COMPLIANCE REPORT

EPBC 2011/6228

Mount Emerald Wind Farm

June 2022

MEWF

RATCH-Australia Corporation

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DOCUMENT STATUS

Version	Purpose of Document	Author	Review	Approval	Date
1	EPBC - Annual Compliance Report	P McDonald	J Lee	J Lee	29-06-2022

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ATTACHMENTS

1. DECLARATION OF ACCURACY

In making this declaration, I am aware that sections 490 and 491 of the Environmental Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) make it an offence in certain circumstances to knowingly provide false or misleading information or documents. The offence is punishable on conviction by imprisonment or a fine, or both. I declare that all the information and documentation supporting this compliance report is true and correct in every particular. I am authorised to bind the approval holder to this declaration and that I have no knowledge of that authorisation being revoked at the time of making this declaration.

Signed:	
Full name (please print):	James Lee
Position (please print):	Executive General Manager
Organisation (please print including ABN/ACN if applicable):	Mount Emerald Wind Farm Pty Ltd ACN – 149 050 322 ABN – 19 149 050 322
Date:	29 June 2022

2. PROJECT DESCRIPTION

The Mount Emerald wind farm site is a large rural allotment (Lot 7 SP235224) comprising some 2,422ha. It is located approximately 3.5km south-west of Walkamin, off Springmount Road at Arriga on the Atherton Tablelands. Topographically, the site is situated at the northern most end of the Herberton Range (part of the Great Dividing Range) with the north-western section of the site being dominated by Walsh's Bluff.

The site is characterised by rugged terrain with elevations of between 540m up to 1089m ASL (above sea level). The town centre of Mareeba is situated approximately 18km to the north of the site, with the town of Atherton approximately 12km south-east of the site.

Other features of the site include a series of ephemeral drainage lines, including the headwaters of Granite Creek. An established 275kV transmission line (Powerlink: Chalumbin-Woree) and its associated easement traverses the site in an east-west direction, broadly bisecting it.

3. PROJECT ACTIVITY STATUS

The project commenced construction on the 7th February 2017.

On the 22nd February 2019, a notice of Commencement of Operation was issued under the terms of the construction contract, as such the wind farm is now considered to be currently in the "Operation" phase.

During this reporting period activities relating to conditions 7, 10, 16 and 21 have occurred and are documented in this report.

4. COMPLIANCE TABLE

No.	CONDITION	DELIVERABLE	DESIGNATION	CURRENT STATUS
General				
1	The action is limited to the construction of a maximum of 63 wind turbines and associated infrastructure on the wind farm site	Max. 63 WTG	COMPLIANT	No further action in this reporting period. Compliance detailed in Year 2 Compliance Report (Attachment A).
2	To minimise impacts to EPBC Act listed threatened species, the approval holder must not disturb more than 78 ha of habitat for EPBC Act listed threatened species on the wind farm site	Max. 78ha of disturbed area	COMPLIANT	No further action in this reporting period. Compliance detailed in Year 2 Compliance Report (Attachment B).
3	Prior to commencement of the action, the approval holder must submit a Turbine Location and Development Footprint Plan identifying the final position of all proposed turbines, access roads and associated operational and maintenance infrastructure, for the written approval of the Minister	Turbine Location and Development Footprint Plan (TLDFP)	COMPLIANT	Approval received 18/1/17. (Previously supplied in 2018 Year 1 Compliance Report) TLDFP sent to DOEE 13/01/2017 TLDFP (Previously suppled in 2019 Year 2 Compliance Report)
4	The Turbine Location and Development Footprint Plan must demonstrate how the approval holder has avoided and minimised disturbance to denning habitat for the Northern Quoll (Dasyurus hallucatus) and to *Grevillea glossadenia* and *Homoranthus porteri*.	Turbine Location and Development Footprint Plan (TLDFP)	COMPLIANT	Approval received 18/1/2017 (Previously supplied in 2018 Year 1 Compliance Report) Documents sent to DOEE 13/01/2017 TLDFP shows locations of plant species (Previously suppled in 2019 Year 2 Compliance Report) Refer to Design Justification Report (Previously supplied in 2018 Year 1 Compliance Report)
5	The approval holder must not commence the action until the Turbine Location and Development Footprint Plan has been approved by the Minister in writing.	Minister Sign-off	COMPLIANT	Approval of TLDFP received 18/1/2017. (Previously supplied in 2018 Year 1 Compliance Report) Date of Commencement 7/2/2017.

No.	CONDITION	DELIVERABLE	DESIGNATION	CURRENT STATUS
6	The Turbine Location and Development Footprint Plan must be implemented	Turbine Location and Development Footprint Plan (TLDFP)	COMPLIANT	Construction completed in compliance with TLDFP. No further action in this reporting period. Compliance detailed in Year 2 Compliance Report (Attachment A).
Northern Quoll Management				
7	For the protection of the Northern Quoll, the approval holder must maintain a viable population of Northern Quoll on the wind farm site.	Northern Quoll population ~50		Current estimate of population remains as per previous study. Year 5 monitoring has been conducted in accordance with the Approved Quoll Outcome Strategy. Refer to Attachment A.
8	The approval holder must prepare and submit an Outcomes Strategy for the Minister's written approval which describes a monitoring program to inform adaptive management and determine whether the outcome required under condition 7 is being or has been met. The Outcomes Strategy must: (a) be prepared by a suitably qualified expert; (b) identify and justify performance measures, which are capable of accurate and reliable measurement, and will be used to measure the outcome required under condition 7; (c) include a monitoring program, to detect changes in the performance measures. The monitoring must include baseline surveys, control sites and experimental design (to test the effectiveness of different management measures); and (d) describe how the baseline and monitoring data will be adequate to: inform adaptive management; enable an objective decision to be made on whether the outcome described in condition 7 has been met.	Northern Quoll Outcomes Strategy (NQOS)	COMPLIANT	Approval received 23/12/16. (Previously supplied in 2018 Year 1 Compliance Report) NQOS submitted 7/12/2016. (Previously supplied in 2018 Year 1 Compliance Report)

No.	CONDITION	DELIVERABLE	DESIGNATION	CURRENT STATUS
9	The approval holder must not commence construction until the Minister has approved the Outcomes Strategy in writing.	Minister Sign-off	COMPLIANT	Approval received 23/12/2016 (Previously supplied in 2018 Year 1 Compliance Report)
10	The approved Outcomes Strategy must be implemented.	Quoll Monitoring Report	COMPLIANT	All Survey Results have been posted to Project WEBSITE. ***www.mtemeraldwindfarm.com.au/compliance/*** USC Survey Work complete; Mt Emerald Wind Farm – Quoll Monitoring Final Report (Attachment A) Year 5 monitoring has been conducted in accordance with the Approved Quoll Outcome Strategy. Refer to Attachment A of this report.
11	If the Minister is not satisfied that either the outcomes required under condition 7 are likely to be achieved, or there is insufficient evidence that the outcomes required under condition 7 are being achieved, the Minister may (in writing) require the approval holder to submit a plan for the Minister's approval to reduce, mitigate, remediate, or offset impacts to matters protected under the controlling provisions of this approval within a designated timeframe. The Minister may require the plan be prepared or reviewed by a suitably qualified person or another person specified or agreed to by the Minister. If the Minister approves the plan then the approved plan must be implemented.	Northern Quoll Mitigation Plan	NOT APPLICABLE	Not required at this time.
Bare-rumped Sheathtail Bat and Spectacled Flying-fox Management				
12	Prior to commissioning, the approval holder must evaluate the effectiveness of suitable measures, including changed cut-in speed, avian radar system and SCADA system, to avoid and mitigate the impacts of turbine collision to Spectacled Flying-fox (*Pteropus conspicillatus*) and Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus nudicluniatus*) on the wind farm site.	Evaluation of Potential Measures to Reduce Turbine Collision	COMPLIANT	Email from DoEE confirming requirements met - 2/6/2017 (Previously supplied in 2018 Year 1 Compliance Report) Report provided to DoEE 5/5/2017. (Previously supplied in 2018 Year 1 Compliance Report)

No.	CONDITION	DELIVERABLE	DESIGNATION	CURRENT STATUS
13	Prior to commissioning, the approval holder must submit to the Minister for written approval, a Wind Farm Implementation Plan that is informed by the results of the evaluation required by condition 12. The Wind Farm Implementation Plan must include: (a) details of intended outcomes and measurable performance criteria for the Spectacled Flying-fox and Bare-rumped Sheathtail Bat which are based on information contained in relevant guidance material including; - *Matters of National Environmental Significance: Significant Impact Guidelines 1.1 Environmental Protection and Biodiversity Conservation Act 1999 (2013);* - *EPBC Act Policy Statement 2.3 Wind Farm Industry (2009); and* - *Draft Referral Guideline for 14 birds listed as migratory species under the EPBC Act (2015).* (aa) a program to implement a *Low Windspeed Curtailment Study*; (b) a program to monitor the effectiveness of progress against performance criteria; and (c) contingency measures and corrective actions that will be implemented if performance criteria are not being or are not likely to be met.	Wind Farm Implementation Plan (WFIP)	COMPLIANT	WFIP approved 4/05/2018 (Previously supplied in 2019 Year 2 Compliance Report) Final WFIP submitted to DoEE 24/4/2018. (Previously supplied in 2019 Year 2 Compliance Report)
14	The Wind Farm Implementation Plan must be reviewed by a suitably qualified expert prior to submission to the Minister for approval. The Wind Farm Implementation Plan must include the findings of the review undertaken by the suitably qualified expert and details of how any recommendations made by the suitably qualified expert have been addressed.	Wind Farm Implementation Plan Review (WFIP)	COMPLIANT	WFIP approved 4/5/2018 (Previously supplied in 2019 Year 2 Compliance Report)

No.	CONDITION	DELIVERABLE	DESIGNATION	CURRENT STATUS
15	The approval holder must not commission the wind farm until the Wind Farm Implementation Plan has been approved by the Minister in writing.	Minister Sign-off	COMPLIANT	WFIP approved 4/5/2018 (Previously supplied in 2019 Year 2 Compliance Report)
16	The approved Wind Farm Implementation Plan must be implemented.		IN PROGRESS	Environmental consultant engaged to undertake the activities as per WFIP. Bird and Bat Collision Mortality Studies Progress Report R2019-016 (previously supplied in Year 3 Compliance Report - Attachment B) Year 1 of Low Windspeed Curtailment Study (previously supplied in Year 4 Compliance Report – Attachment A) Year 2 of Low Windspeed Curtailment Study – submitted to DAWE on 26 May 2022. Refer to Attachment B of this report.
17	Upon the direction of the Minister, the approval holder must cease to operate any specified wind turbine generator/s if the Minister considers that, based on compliance reporting required by condition 26, they are having an impact on Bare-rumped Sheathtail Bat and Spectacled Flying-fox greater than the performance criteria required by condition 13(a) that cannot be mitigated or compensated.	Operational Strategy		Not required at this time.
Offsets				
18	To compensate for residual significant impacts to EPBC Act listed threatened species, the approval holder must provide environmental offsets that comply with the principles of the EPBC Act Environmental Offsets Policy.	Offset Area Management Plan (OAMP)	COMPLIANT	Approval of OAMP provided 20/12/2016 (Previously supplied in 2018 Year 1 Compliance Report) Response and final OAMP submitted 16/12/2016. (Previously supplied in 2018 Year 1 Compliance Report)

No.	CONDITION	DELIVERABLE	DESIGNATION	CURRENT STATUS
19	The approval holder must prepare and submit an Offset Management Plan to the Minister for approval in writing . The Offset Management Plan must include: (a) details of the minimum offset areas proposed to compensate for the loss of habitat for EPBC Act listed threatened species from the wind farm site, (b) information about how the offset area/s provide connectivity with other relevant habitats and biodiversity corridors, including a map depicting the offset areas in relation to other habitats and biodiversity corridors; (c) a description of the management measures that will be implemented on the offset site for the protection and management of habitat for EPBC Act listed threatened species, including a discussion of how measures proposed are consistent with the measures in conservation advice, recovery plans and relevant threat abatement plans; (d) performance and completion criteria for evaluating the management of the offset area/s, and criteria for triggering remedial action (if necessary); (e) a program, including timelines to monitor and report on the effectiveness of these measures, and progress against the performance and completion criteria; (f) a description of potential risks to the successful implementation of the plan, and a description of the contingency measures that would be implemented to mitigate against these risks; (g) the proposed legal mechanism and timelines for securing the offset/s; and (h) a textual description and map to clearly define the location and boundaries of the offset area. This must be accompanied with the offset attributes and a shapefile.	Offset Area Management Plan (OAMP)	COMPLIANT	Approval of OAMP provided 20/12/2016 (Previously supplied in 2018 Year 1 Compliance Report) Response and final OAMP submitted 16/12/2016. (Previously supplied in 2018 Year 1 Compliance Report)

No.	CONDITION	DELIVERABLE	DESIGNATION	CURRENT STATUS
20	The approval holder must not commence construction until the Offset Management Plan has been approved by the Minister in writing.	Minister Sign-off	COMPLIANT	Approval of OAMP provided 20/12/2016 (Previously supplied in 2018 Year 1 Compliance Report)
21	The approved Offset Management Plan must be implemented	Monitoring Report	COMPLIANT	2017 Monitoring Report submitted 17/04/2018 2018 Monitoring Report submitted 6/12/2018 2019 Monitoring Report submitted 17/7/2019 2020 BioCondition Survey submitted 4/12/2020 2021 Monitoring Report submitted 28/09/2021. Refer to Attachment C of this report. 2022 BioCondition Survey submitted 29/6/22. Refer to Attachment D of this report.
Administrative Conditions				
22	To avoid duplication, the approval holder may provide the Minister with plans and strategies prepared for the State and/or an Authority provided the plans, and/or strategies meets the conditions specified in this approval. The plans and/or strategies must include a cross reference table that clearly identifies: (a) the condition specified in the approval for which the plan or strategy is being provided; and (b) the relevant folder, chapter, section number and page number in the plan or strategy where the condition has been addressed.		NOT APPLICABLE	Plans and Strategies have been provided to directly address conditions of this approval.

No.	CONDITION	DELIVERABLE	DESIGNATION	CURRENT STATUS
23	Within 10 business days after the commencement of the action, the approval holder must advise the Department in writing of the actual date of commencement.	Notification of Commencement of Construction	COMPLIANT	Date of Commencement 7 February 2017. Notice provided 13/2/2017 (Previously supplied in 2018 Year 1 Compliance Report) and acknowledged. (Previously supplied in 2018 Year 1 Compliance Report)
24	The approval holder must maintain a dedicated webpage on compliance with these conditions that is publically available on the approval holder's website for the life of the approval. The webpage must include: • a copy of the approval conditions (and any subsequent variations or other formal changes to the approval); • all monitoring results and • documentation required under these conditions and any other relevant information as directed by the Minister in writing. Unless otherwise agreed to in writing by the Minister, the approval holder must provide a copy of documents required to be published on the dedicated webpage to members of the public upon request, within a reasonable time of the request.	Website	COMPLIANT	EPBC Decision Notice and Conditions placed on website. **www.mtemeraldwindfarm.com.au/compliance/**

No.	CONDITION	DELIVERABLE	DESIGNATION	CURRENT STATUS
25	The approval holder must maintain accurate records substantiating all activities associated with or relevant to the conditions of approval, including measures taken to implement any plans and strategies required by this approval and measures taken to achieve the outcomes specified in conditions 7 and 13 and make them available upon request to the Department. Such records may be subject to audit by the Department or an independent auditor in accordance with section 458 of the EPBC Act, or used to verify compliance with the conditions of approval. Summaries of audits will be posted on the Department's website. The results of audits may also be publicised through the general media.	File management		
26	Within three months of every 12 month anniversary of the commencement of the action, the approval holder must publish a report on the webpage required in condition 24 addressing compliance with each of the conditions of this approval, including implementation of any plans and strategies as specified in these conditions and whether the outcome required by conditions 7 and 13 have been or are track to being met. The compliance report must consider the Department's Annual Compliance Report Guidelines. Documentary evidence providing proof of the date of publication and non-compliance with any of the conditions of this approval must be provided to the Department at the same time as the compliance report is published.	EIS Compliance Report	COMPLIANT	Date of Commencement 7 February 2017. 2018 Year 1 Compliance Report – issued. 2019 Year 2 Compliance Report – issued. 2020 Year 3 Compliance Report – issued. 2021 Year 4 Compliance report – issued. 2022 Year 5 Compliance report (this report)
27	The approval holder must report any contravention of the conditions of this approval to the Department within 2 business days of the approval holder becoming aware of the contravention.	Notification of Contravention	COMPLIANT	No contravention identified.

No.	CONDITION	DELIVERABLE	DESIGNATION	CURRENT STATUS
28	Upon the direction of the Minister, the approval holder must ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the Minister. The audit must not commence until the Minister has approved the independent auditor and audit criteria. The audit report must address the criteria to the satisfaction of the Minister.	Independent Audit	NOT APPLICABLE	No direction from Minister at this time.
29	The approval holder may choose to revise a plan or strategy approved by the Minister under conditions 3, 8, 13 and 19 without submitting it for approval under section 143A of the EPBC Act, if the taking of the action in accordance with the revised plan or strategy would not be likely to have a new or increased impact. If the approval holder makes this choice they must: (a) notify the Department in writing that the approved plan or strategy has been revised and provide the Department with an electronic copy of the revised plan or strategy; (b) implement the revised plan or strategy from the date that the plan or strategy is submitted to the Department; and (c) for the life of this approval, maintain a record of the reasons the approval holder considers that taking the action in accordance with the revised plan or strategy would not be likely to have a new or increased impact.	Revised Plans: #3 - Turbine Location and Development Footprint Plan #8 - Northern Quoll Outcomes Strategy #13 - Wind Farm Implementation Plan #19 - Offset Area Management Plan	NOT APPLICABLE	TLDFP submitted 13/1/2017; approved 18/1/2017 TLDFP as-built (Previously suppled in 2019 Year 2 Compliance Report) NQOS submitted 7/12/2016; approved 23/12/2016 WFIP submitted 24/4/2018; approved 4/5/2018 OAMP submitted 16/12/2016; approved 20/12/2016
30	The approval holder may revoke its choice under condition 29 at any time by notice to the Department. If the approval holder revokes the choice to implement a revised plan without approval under section 143A of the Act, the approval holder must implement the version of the plan most recently approved by the Minister.	Revised Plans	NOT APPLICABLE	No revisions made at this time.

No.	CONDITION	DELIVERABLE	DESIGNATION	CURRENT STATUS
31	Condition 29 does not apply if the revisions to the approved plan or strategy include changes to environmental offsets provided under the plan or strategy in relation to a matter protected by a controlling provision for the action, unless otherwise agreed in writing by the Minister. This does not otherwise limit the circumstances in which the taking of the action in accordance with a revised plan or strategy would, or would not, be likely to have new or increased impacts.	Revised Plans	NOT APPLICABLE	No revisions made at this time.
32	If the Minister gives a notice to the approval holder that the Minister is satisfied that the taking of the action in accordance with the revised plan would be likely to have a new or increased impact, then: (a) condition 29 does not apply, or ceases to apply, in relation to the revised plan; and (b) the approval holder must implement the version of the plan most recently approved by the Minister. To avoid any doubt, this condition does not affect any operation of conditions 29 and 30 in the period before the day after the notice is given.	Revised Plans	NOT APPLICABLE	No revisions made at this time.
33	At the time of giving a notice under condition 32, the Minister may also notify that for a specified period of time condition 29 does not apply for one or more specified plans required under the approval.	Revised Plans	NOT APPLICABLE	No revisions made at this time.
34	Conditions 29, 30, 31 and 32 are not intended to limit the operation of section 143A of the EPBC Act which allows the approval holder to submit a revised plan to the Minister for approval.	Revised Plans	NOT APPLICABLE	No revisions made at this time.
35	If, at any time after five years from the date of this approval, the approval holder has not substantially commenced the action, then	Drop Dead Date - 26 November 2020	COMPLIANT	Refer to Condition 23.

No.	CONDITION	DELIVERABLE	DESIGNATION	CURRENT STATUS
	the approval holder must not commence the action without the written agreement of the Minister.			

A. NORTHERN QUOLL MONITORING REPORT

Northern Quoll Monitoring Report

Mount Emerald Wind Farm (2021)

4 elements

Northern Quoll Monitoring Report

Mount Emerald Wind Farm (2021)

Revision History

Version	Purpose	Issued by	Date	Reviewer	Date
1	Draft	C Starr and M Vickers	03.03.2022	M. Brown	05.03.2022
2	Final	C Starr and M Vickers	19.03.2022	M. Brown	22.03.2022

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1.0 Summary

The following report provides data from targeted Northern Quoll and BioCondition monitoring carried out on two sites at Mount Emerald Wind Farm (MEWF), and three control sites located on the Walsh River, Brooklyn Reserve and Davies creek. This monitoring program has been conducted to satisfy conditions of approval relating to Northern Quoll Management under Mount Emerald Wind Farm's Approval under the *Environmental Protection and Biodiversity Conservation Act 1999* (2011/6228). The methodology complies with the approved Mount Emerald Wind Farm, Northern Quoll Outcomes Strategy, December 2016, R76073/PR130417-2 (Quoll Outcome Strategy).

Non-target data on wild dog/dingo, feral cat, and toad were also captured on camera traps. Three sampling periods occurred in 2021 (March, July and October), with cameras deployed at each site for a minimum of 14 trap nights. Trapping grids at each site consisted of 36 camera survey points, encompassing 306.25 ha at each survey site, with 180 survey points overall (1,531.25 ha). This report follows prior monitoring by the University of the Sunshine Coast (Burnett et al. 2019) which investigated if a similar trajectory in number and occupancy of Northern Quoll were observed between MEWF and control sites during construction, and wind farm operations. BioCondition sampling occurred within each site, as per the sampling carried out by Burnett et al. (2019). If quoll numbers, or occupancy were to significantly differ between MEWF and control sites, the Quoll Outcome Strategy requires a management action by MEWF to reduce impact and to protect these populations.

Our data identifies a significant difference in estimated quoll populations amongst the samples during this study, which is likely to be a seasonality factor influencing quoll numbers at all sites. There was no interaction, and no effect of treatment on quoll numbers (impact or control sites). Occupancy data identified a similar trend, with no effect of treatment on quoll occupancy, however again there were an effect of season. Essentially, whatever patterns are seen at Mount Emerald in quoll numbers and occupancy is occurring across all sites, and therefore not an effect of wind farm operations.

Additionally, there was no overall effect of treatment (wind farm vs control) on feral animal numbers across the sites. Whilst not statistically significant, due to limited cat data, there did appear to be decline in quolls where cats were present. The methodology was not established to specifically target cats, however, as cats were only detected on the wind farm sites and Walsh River. Further monitoring and targeted control of feral animals is planned for MEWF in 2022, to mitigate future impacts on Northern Quoll populations.

There was no effect of vegetation based on the measured habitat metrics assessed, nor season on quoll populations across the sites from this study.

In summary, the data suggests Mount Emerald Wind Farm is not affecting number or occupancy of Northern Quoll during our study period.

2.0 Introduction

The Mount Emerald Wind Farm site is located approximately 20 km SSW of Mareeba on the Atherton Tablelands in North Queensland at the northern extent of the Herberton Range. Construction of the MEWF was completed in 2019 and now operates as a generator within the National Electricity Market.

The northern half of the project site has broad, rolling hills, with dissected areas found in ravines and gorges; whereas the land to the south of the existing 275 kV powerline is markedly rugged and steeply dissected, rendering the highest points a series of narrow ridges and rocky knolls with steep drop-offs on adjacent slope faces. A total of 53 individual wind turbine pads have been connected by a network of constructed access roads, some of which accommodate underground cabling. Further cleared areas, running parallel to this road infrastructure, were constructed for additional cabling requirements. A substation and contractors' compound have been constructed approximately central to the road network on the project site.

The project received approval under the *Environmental Protection and Biodiversity Conservation Act 1999* (2011/6228), which stipulated provisions for the management of construction and operational activities where the Northern Quoll is known to inhabit. Conditions 7 of the Approval requires that a viable population of the Northern Quoll be maintained at the wind farm site. The methodology for monitoring and developing adaptive management actions are described in the approved *Mount Emerald Wind Farm, Northern Quoll Outcomes Strategy, December 2016, R76073/PR130417-2 (Quoll Outcome Strategy)*. Monitoring has occurred through construction and operations through 2017-2019 by the University of the Sunshine Coast, which concluded no evidence of changes in the population of quolls across the survey period. This 2021 report follows the work completed by the University of the Sunshine Coast and satisfies the requirements of the Quoll Outcome Strategy.

The Northern Quoll, *Dasyurus hallucatus*, is listed by both the IUCN and Australian Federal Government as 'Endangered'. Large-scale population decline and numerous localised extinctions have occurred across most of north-eastern Australia (Covacevich and Archer 1975, Burnett 1997, Woinarski et al. 2008). This species is known to have declined due to the spread of Cane Toads which poisons quolls when predated upon. Cane Toads reached southern Cape York around 1980, and by 1995 had reached the tip of the Cape. Decline has occurred sequentially with toad incursion, from Queensland, west across the Top End of Australia towards Western Australia. The expiration of numerous populations has now been well documented in the Northern Territory (Woinarski et al. 2011). Woinarski et al. (2014) estimates the overall national population decline in the last decade to be >50%, with an estimated further >50% loss predicted for the remaining populations in the following decade . However, some populations are showing signs of toad avoidance in some limited areas of North Queensland, with documented field observations on camera traps from Brooklyn Station (Australian Wildlife Conservancy, unpublished data), South Endeavour Station (Starr et al. 2016) and Caloola Station (Starr and Waller 2017).

Additional known threats to the species are inappropriate fire regimes (Andersen. 2012), predation by feral cats and wild dogs (Hill and Ward 2010).

The national recovery plan recommends future emphasis on protecting key populations of Northern Quoll across its range (Hill and Ward 2010). The MEWF site consists of dry forests on the northern tablelands and the hills and slopes are identified by prior studies as important refugia for this species (Burnett et al. 2013). Prior monitoring at the Mount Emerald site monitored key vegetation attributes, as well as feral carnivores and cane toads (Burnett et al 2019), with the goal of better understanding any changes in quoll numbers. Data from this former study involved 6 survey periods, and provided assessment of trends in individuals, modelled population size and occupancy compared to control sites. Seasonal progress reports identified no obvious change in quoll numbers (however some change in occupancy), or the habitat metrics that were monitored. Data were further analysed in a comprehensive report, and this provided observations regarding variation in the quoll population through the survey period, when construction was occurring. The final report suggested a potential decline in juveniles and reduced breeding success in the time since construction-however this was not statistically conclusive. This study is a continuation of the earlier work, where similar data collection and analysis were carried out, to assess if populations and habitat variables have remained consistent in the years since construction, and with ongoing management at the site.

3.0 Methods

Plot based camera trapping and BioCondition transect assessments were carried out on two impact sites (Mt Emerald 1 and 2) located on Mount Emerald Wind Farm, and three nearby control sites (Walsh River, Brooklyn Sanctuary and Davies Creek). Each site had a 6 x 6 station grid, with each trap placed 350 m apart, as specified in the Quoll Outcome Strategy. This gave 36 survey points, encompassing 306.25 ha at each survey site, and 180 survey points overall (1,531.25 ha).

3.1 Camera trapping

Camera traps were baited at each survey point to collect data on Northern Quoll which were used to carry out capture-recapture and site occupancy analysis. Data on Dingo/ild dog *Canis familiaris/Dingo*, feral cat *Felis catus*, feral pig *Sus scrofa* and Cane Toad *Rhinella marina* were also collected to record relative abundance of these species; however, we note this is not considered an ideal monitoring tool to accurately monitor some of these species. Three samples were recorded at each site in 2021. Cameras were deployed for 14 days at each sampling period. Figure 1 and Table 1 identify the location of survey sites for this study.

RECONYX Hyperfire® (HC550 and HP2W) and Bolyguard® (SG 562-C and 2060-D) camera traps were placed at each sample location (**Plate 1**). Cameras were mounted horizontally on a picket or tree trunk, 150 cm above the bait station, aimed perpendicularly to the ground as per former sampling periods (Burnett et al 2019). The bait cannister consisted of a PVC plumbing cowl secured at each end with a plumbing cap and ventilation cowl. These contained chicken necks to lure quolls to the camera station. Reconyx camera traps were deployed for a minimum of 14 trap nights, operating for 24 hours, taking three images per event.

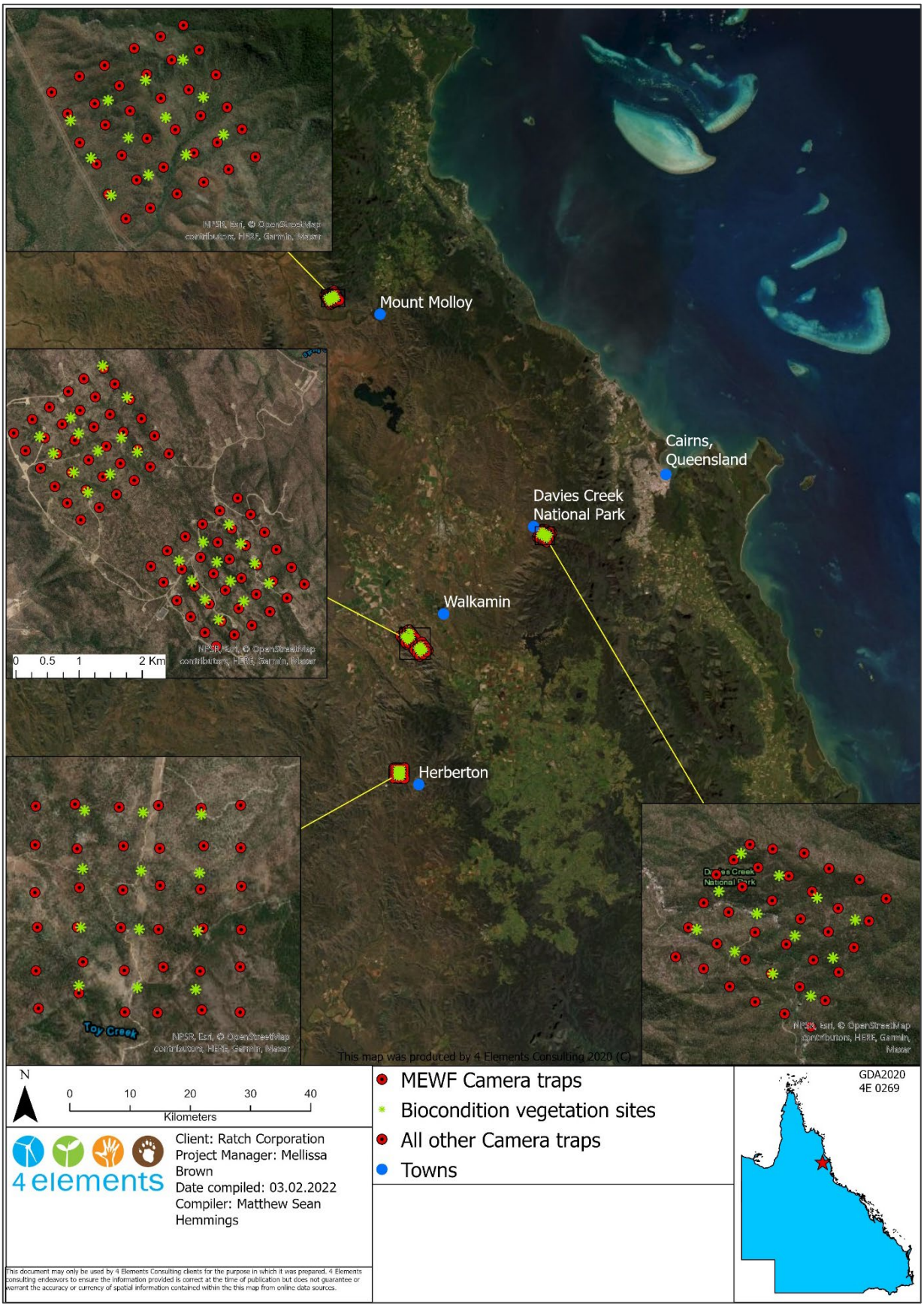

Figure 1. Location of the camera trapping stations, and BioCondition locations surveyed during this study.

Table 1. Site locations and survey periods across the three census periods.

Site	Type	Monitoring dates		
		Survey 1	Survey 2	Survey 3
Mt Emerald 1	Impact	22/02-21-08/03-21	12/7/21-26/7/21	5/10/21-19/10/21
Mt Emerald 2	Impact	24/02/21-10/03/21	14/7/21-29/7/21	6/10/21-22/10/21
Brooklyn Sanctuary	Reference	15/03/21-1/04/21	16/7/21-3/8/21	28/10/21-17/11/21
Davies Creek	Reference	30/03/21-13/04/21	4/8/21-18/8/21	25/10/21-8/11/21
Walsh River	Reference	22/03/21-7/04/21	6/8/21-20/8/21	3/11/21-18/11/2021

Plate 1. The camera facing the bait station, allowing for a horizontal image of the quolls and their individual markings.

3.2 BioCondition Assessments

Habitat census involved a modified BioCondition method (Burnett et al. 2019), originally developed by Eyre et al. (2011). The modification involved an increase to the woody debris plot to 100 x 200 m (originally 50 x 20 m). Surveys were carried out at half of the trapping locations at each quoll monitoring census (Figure 1). BioCondition

plots were located so that the camera point was the centre point of the transect, except where the terrain meant this was not possible.

3.3 Data Analysis

3.3.1 Fauna data

All images were tagged in EXIF PRO® by species and individual, with the data used for further analysis in *camptrapR* (Niedballa et al. 2017) within the R statistical environment (R core Team 2016). Data was first checked to ensure the time and date were correct in each of the images to allow for correction prior to analysis. This species-specific interval was determined with photographic data of known individuals identified by natural marking to be 15 minutes for the Northern Quoll (Diete, Meek et al. 2016), and this were used for analysis. Non-target species were not able to be identified down to the individual.

As per prior monitoring by Burnett et al. (2019) Northern Quolls were assessed at each site and session using the following analysis:

- Minimum number known to be alive (KTBA)- this is the number of unique individuals photographed and identified in each of the sampling sessions;
- Estimate of population size using R-package *RMARK* ;
- A Naïve occupancy- the number of camera trap stations where quolls were detected, and expressed as a proportion of all those stations;
- Occupancy estimate generated using the R-package *unmarked* (Fiske 2011)

3.3.2 Habitat metrics

Vegetation sampling followed the prior methodology which used a modified BioCondition assessment at the site by Burnett et al. (2019), which recorded:

- Recent fire history;
- Woody debris at 20 m x 100 m plots;
- Species richness of trees, shrubs, grasses and forbs;
- Average percent of bare ground cover across five $1m^2$ quadrats separated by 10 m along a 100 m transect. Data were recorded on native perennial and annual grass cover, native forbs, native shrubs (‹1 m height), non-native grasses, non-native forbs, litter, rocks and cryptograms;
- Length of canopy cover; and
- Shrub cover along the same 100 m transect.

4.0 Results

4.1 Quoll populations

There were 422 distinct quoll observations during this sampling period. This ranged from 0 to 30 individuals per site sampled (mean = 11.3 individuals, SD=8.1), with the highest estimates identified on Brooklyn Reserve, and lowest in the Walsh River control site (Figure 2).

There was a significant difference in estimated quoll populations amongst the samples (p=<0.01), however, no interaction and no effect of treatment (impact or control site) (Table 2).

Table 2. Mixed effects linear model testing effect of treatment and season on estimated population size of Northern quoll.

	Num DF	Den DF	F-value	P-value
Intercept	1	531	7.52	0.006
Treatment	1	3	0.06	0.81
Sample	2	531	10.12	<0.01
Treatment: Sample	2	531	0.70	0.49

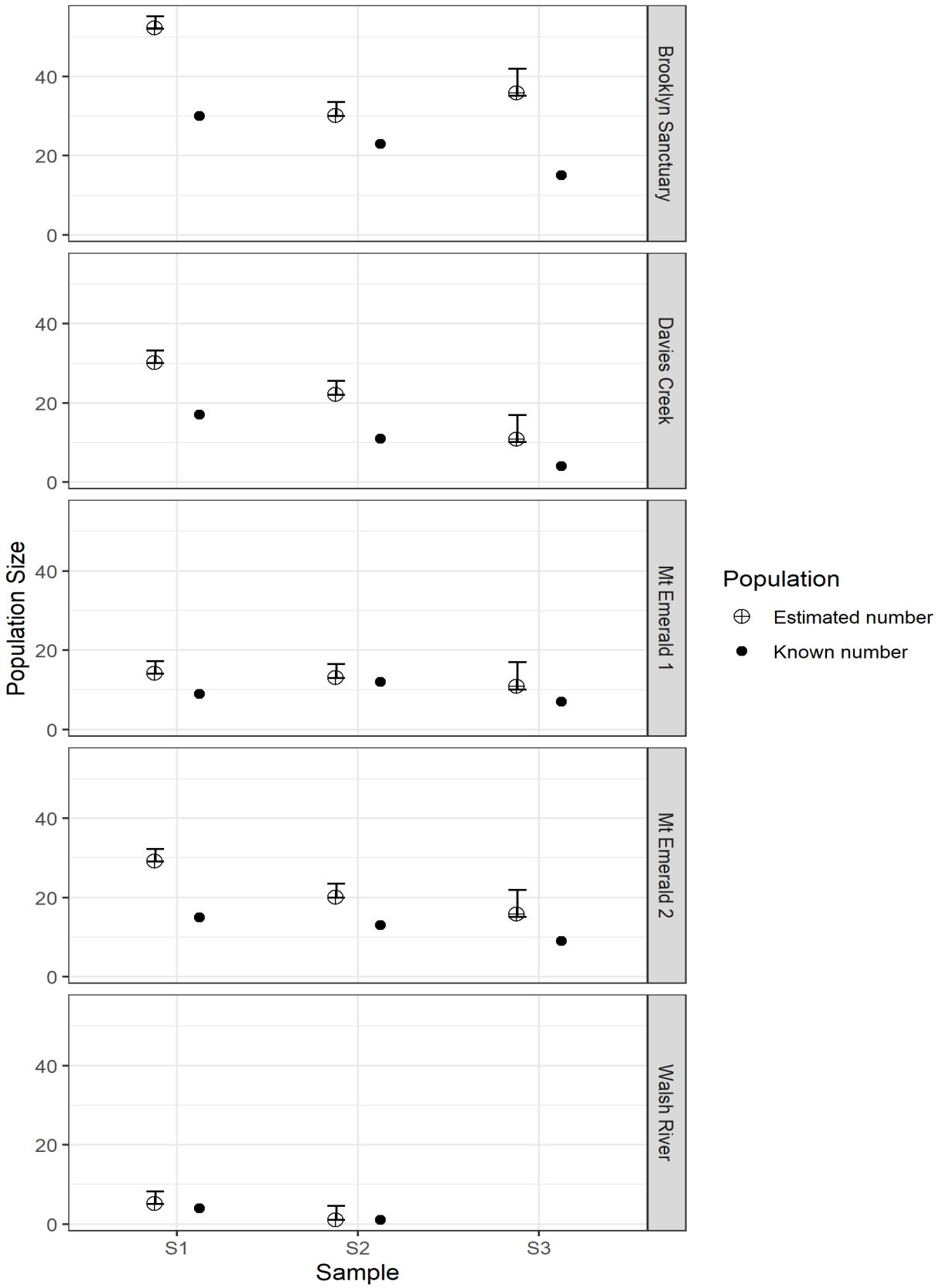

Figure 2. Estimated population size with asymmetric SD estimates using Bayesian estimation, and minimum number of quolls known to be alive (camera) at each site at each season. (mark-recap-daily-camtrap.R)

The proportion of stations where quolls were detected varied from 0 to 0.75 across the sampling periods at the sampling sites (Figure 3). There was an overall decline in occupancy across both control and treatment sites, except for Brooklyn Reserve where 60-75% of cameras detected quolls across the study period (Figure 3). There is an evident seasonal effect, with fewer quolls in S3.

There was no effect of treatment on quoll occupancy, however, as with the estimated populations there was an effect of season (p=0.02 and p=0.01) (Table 3). Figure 4 provides the Bayesian occupancy method accounting for error in quolls potentially missed by the total observed (Figure 3).

Table 3. GLMM testing the effect of treatment on quoll occupancy.

	Estimate	Standard Error	Z value	P-value
Intercept	-0.31	0.80	-0.38	0.70
Treatment Impact	0.13	1.24	0.11	0.91
Sample2	-0.78	0.34	-2.31	0.02
Sample3	-0.84	0.34	-2.47	0.01
TreatmentImpact:Sample2	0.43	0.48	0.89	0.37
TreatmentImpact:Sample3	0.03	0.49	0.07	0.94

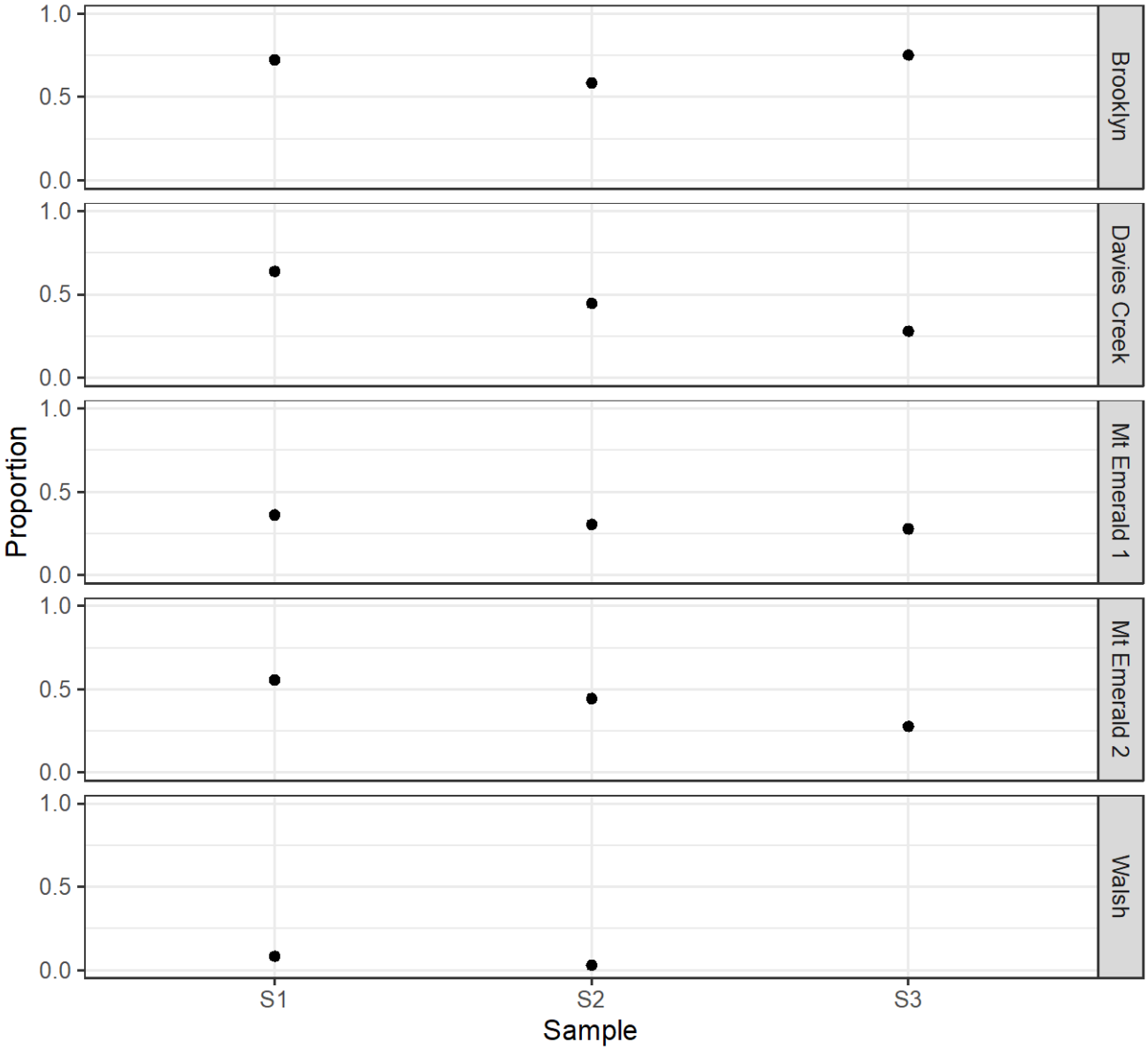

Figure 3. **Site occupancy rate by Northern Quoll. Observed proportion of sites occupied by at least one quoll at each site, broken into seasons.**

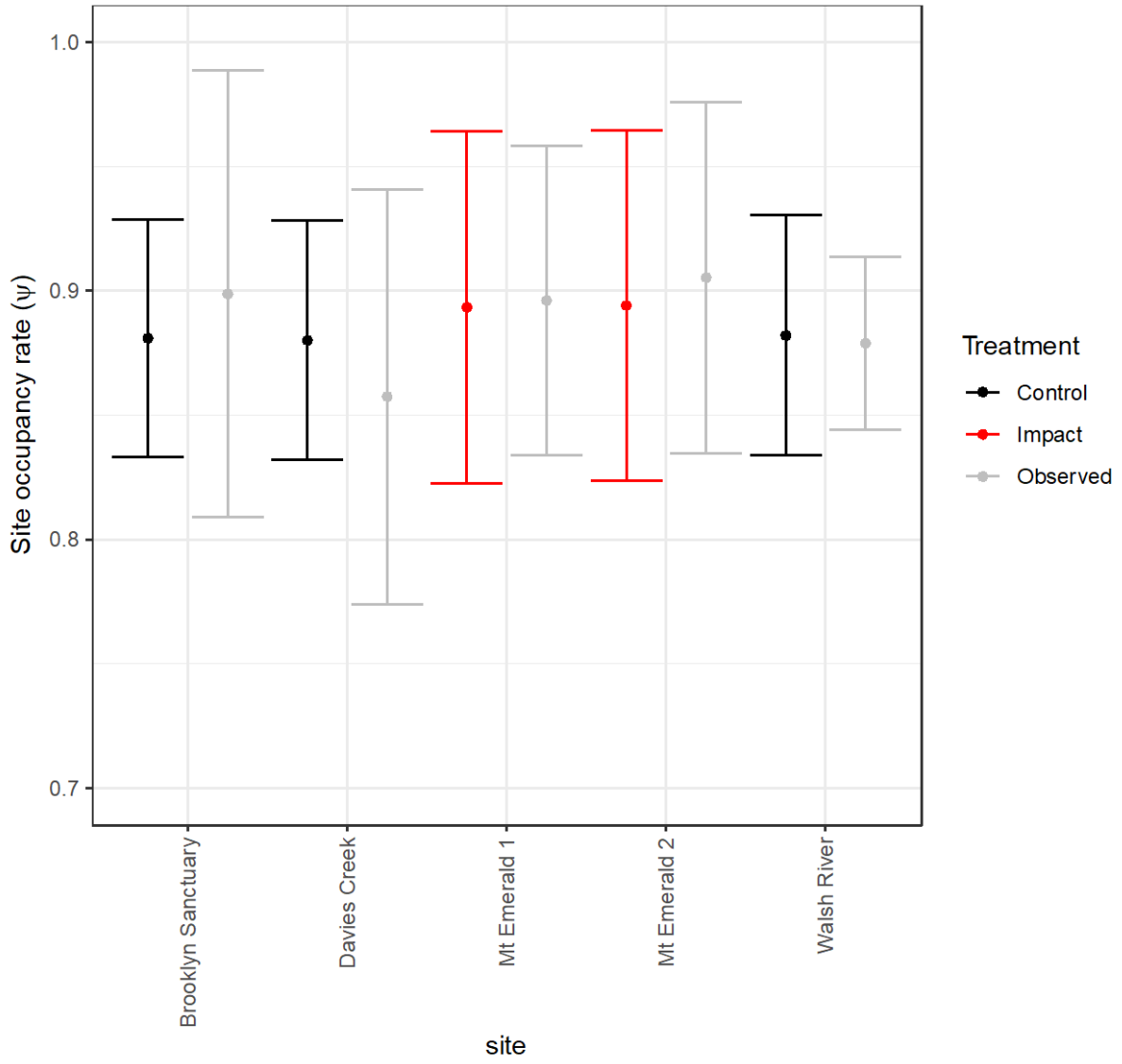

Figure 4. Observed (grey) and predicted (Bayesian method, black/red) site occupancy rate: the proportion of sites where quolls were observed to occur or predicted to occur using package unmarked. This is not by sample (S1, S2, S3), as the data were too scarce to construct meaningful error bars at that resolution.

4.2 Feral animals

There was no effect of treatment on feral animal populations (combined data) identified in this study (i.e., feral animal numbers did not differ between wind farm and control sites). Figure 5 provides the numbers of each pest species recorded during the study.

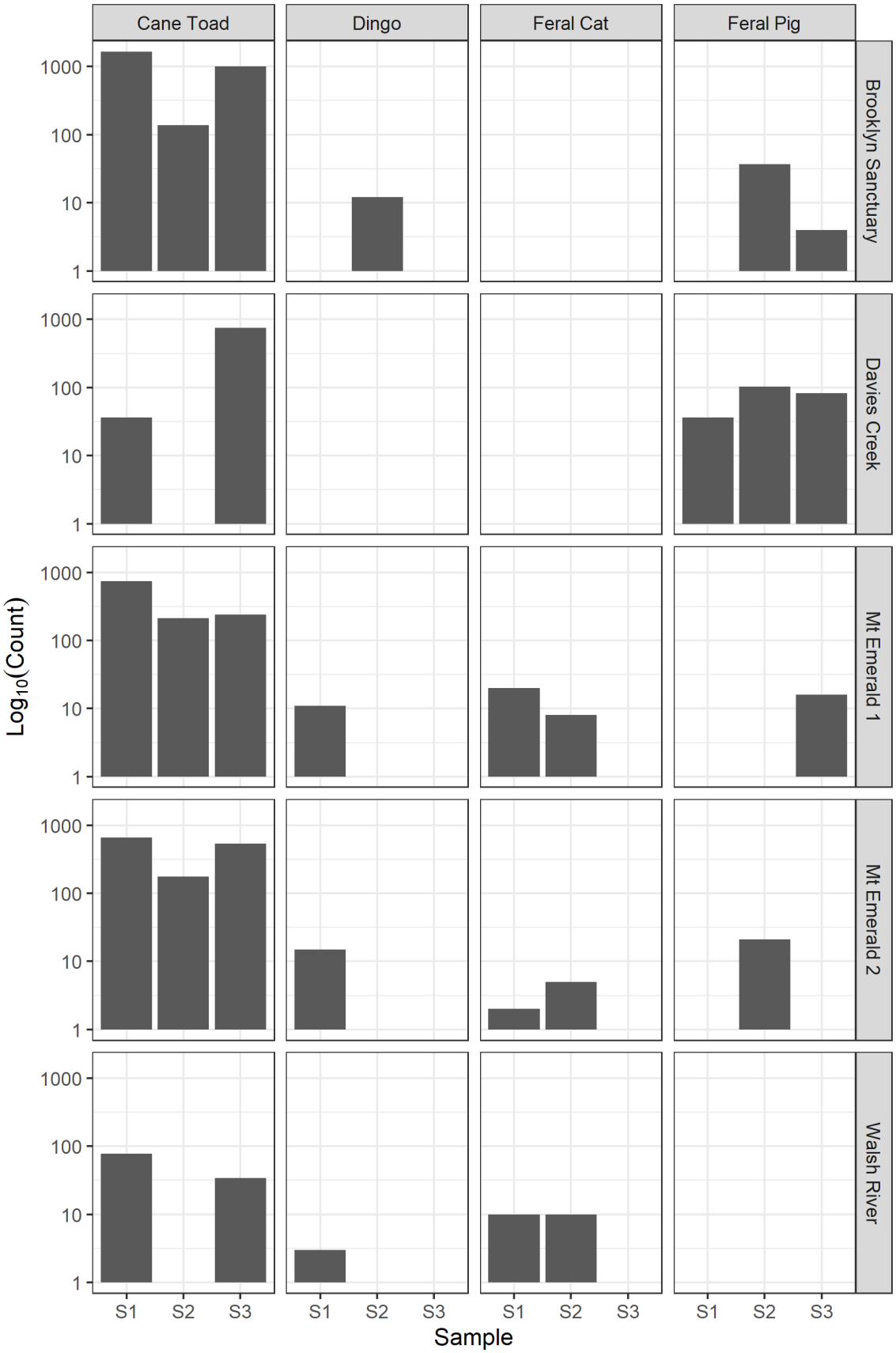

Figure 5. **Feral animals recorded across the sites. Note the log-scale on the y axis. This is presented to improve visibility of rare events (e.g. 2 cats, S1, ME2).**

Feral cats were only detected at the Walsh control site and two treatment sites on Mount Emerald during the study, and there was no significant difference between number of cats between treatments ($F_{1,13}$=1.3, p= 0.27). There was no significant effect on feral cats on Northern Quoll ($F_{1,13}$=1.86, p=0.20), however, the data did show a decline in quolls where cats were present (Figure 5). The methodology was not specifically established to measure cats, and this may change with more targeted feral cat monitoring.

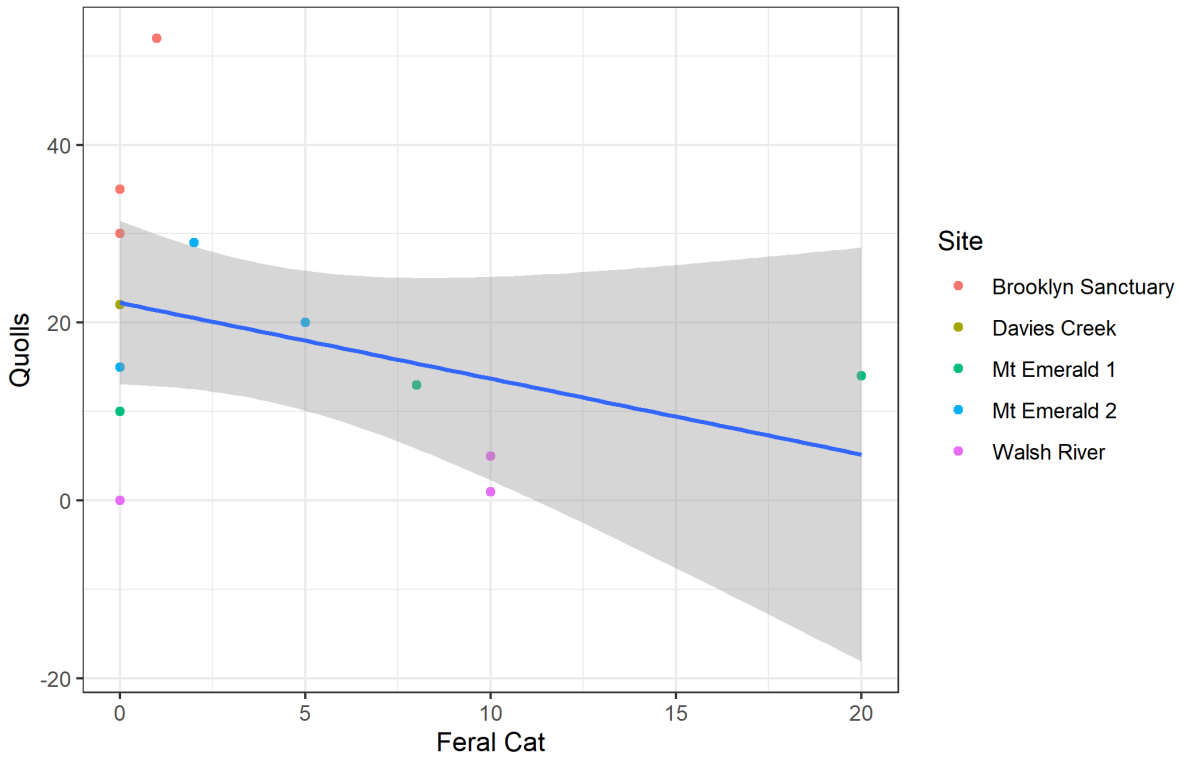

Figure 6. Number of quolls (predicted) vs number of qat observations. We assumed an independent detection time for cats as 15 minutes, as used for Northern Quoll. The smooth line is the linear model fit, with 95% confidence interval.

4.3 Changes in habitat

Our data collection followed the methodology established at the commencement of Northern Quoll monitoring at the site, which involved targeted BioCondition sampling. We initially constructed a multi-factor-analysis to determine if any of these variables allowed for site separation, and to look at how different the sites may be. MFA reduced the 19-dimensions to a more plottable, and easy to visualise 6 dimensions. The first two dimensions explained most of the variation (Figure 7 and Figure 8). There was a qualitative difference among sites, with ME2 being distinct in vegetation from the other sites, seen by the separation of ME1 (Figure 7). This was primarily driven by the abundance of large eucalypt trees (more at ME1), and the leaf litter (less at ME2, figure 8). There was some separation among the other sites due to canopy cover: more at Davies, Walsh River, and Brooklyn in order, and less at ME2, and grass cover: more at ME1 and ME2, less at Brooklyn, Walsh and Davies, in order (Figure 7, 8).

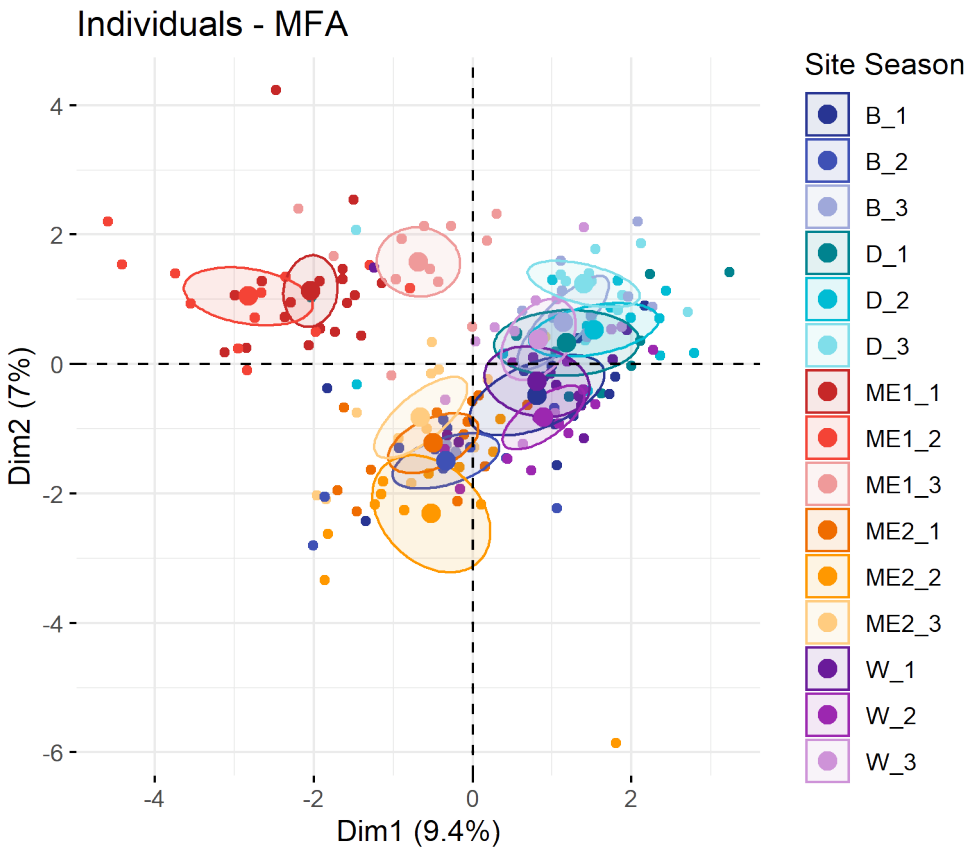

Figure 7. First two dimensions of MFA of 19 vegetation variables measured at each site at 3 seasons. Each point represents one vegetation survey. Warm colours (red, orange) are Control, cool colours (Blues) are Control, colour density represents season. One 95% confidence ellipse was constructed per season per site. ME1 separates from the other sites which cluster very heavily. There was no consistent pattern due to seasonality

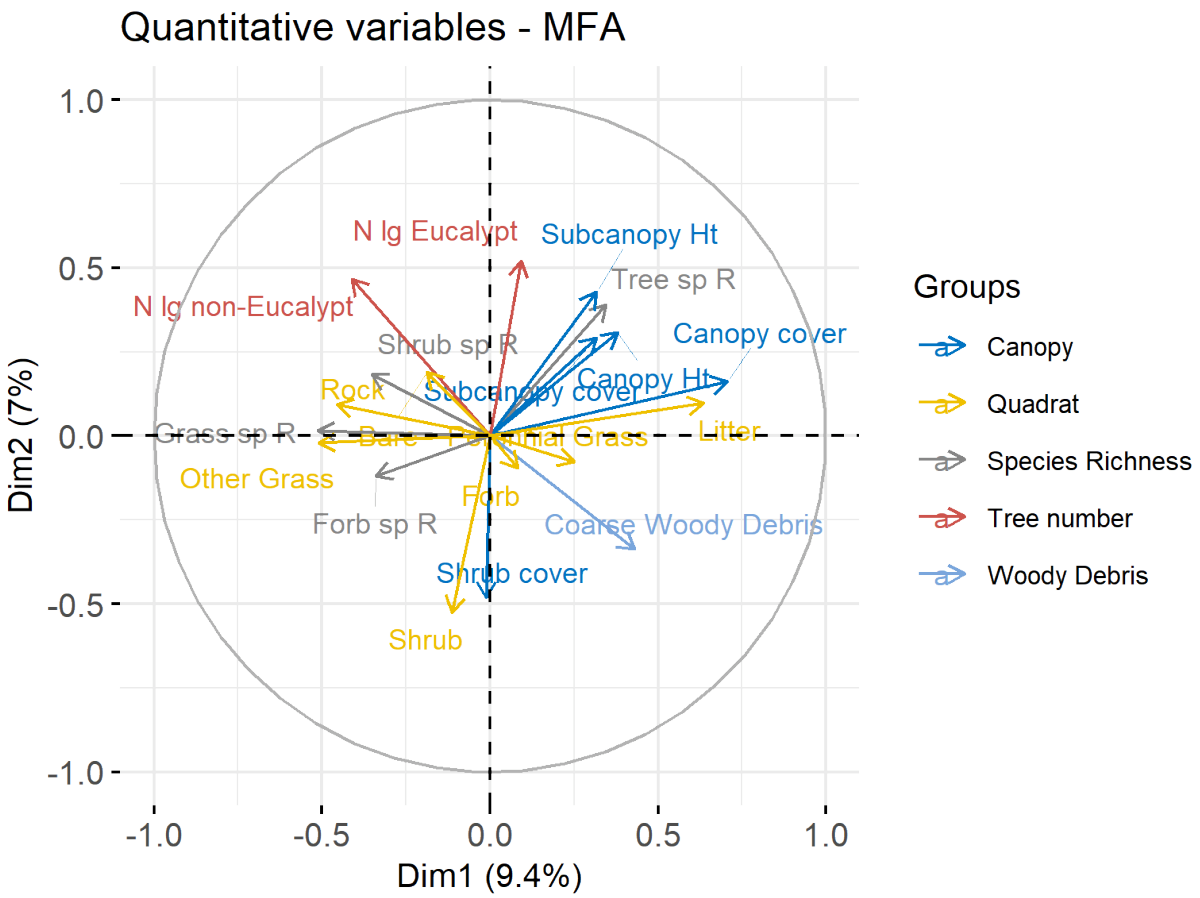

Figure 8. Vegetation shifts in various directions on the MFA plot, i.e., which qualities of vegetation drive the patterns visible in Figure 8. ME1 is up and right from the rest of the sites, driven by increase in the N lg non-Eucalypt, and a decrease in Coarse Woody Debris. Davies has increased subcanopy height compared to other sites, ME1 has more shrubs and grasses, but overall, ME1, D, B, W are clustered and strongly overlapping.

We used the dimension 1 and 2 scores as predictors to determine if vegetation and season influenced quoll population size. The predictors were the covariance of leaf litter, canopy cover, and N lg Eucalypt and non-Eucalypt. There were no effect of vegetation nor season on quoll population size based on these assessed metrics (**Table 4**).

Table 4. Vegetation attributes and quoll populations

	DF	Sum of Squares	Mean Squares	F value	p-value
Season	2	238.13	193.1	0.66	0.55
PCA1	1	27	27	0.09	0.77
PCA2	1	0.95	0.95	0.003	0.96
Season:PCA1	2	378.4	189.2	0.65	0.56
Season:PCA2	2	272.3	136.1	0.47	0.65
Residuals	6	1752.2	292.0		

5.0 Discussion

The data presented here shows no significant difference between quoll populations or site occupancy across impact and control sites. As this study only occurred over a year, we did not measure any longerterm temporal change in quolls at MEWF, which were captured in prior reports by Burnett et al. (2019). The population numbers or occupancy of quolls in this study do not appear to have declined at Mount Emerald 1 or 2 based on studies in 2017, 2018 and 2019 (Burnett et al, 2019), however, our analysis varied slightly and a re-run of all data would be required to quantify any statistical change from 2017 to 2021. Change in occupancy may have occurred in prior study years (Burnett et al., 2019), however there does not appear to be any further decline in 2021. This earlier find by Burnett et al. (2019) is not surprising, and it is plausible initial construction activity influenced the way in which quolls utilised the sites. Season did significantly affect number and occupancy of quoll across the year; however, this was also observed in the control sites and likely to be a natural fluctuation in this species populations.

Feral animals (cats, toads, dogs, and pigs) did not significantly differ in their numbers across the Wind Farm and control sites. The data collected on these species, however, was opportunistic with camera traps, and not species specific in method. Feral cats were detected at the Walsh and the Mount Emerald sites, as per prior studies (Burnett et al., 2019). Whilst there were limited data on cats, there did appear to be fewer quolls where cats were present. Camera traps are known to underestimate feral cat abundance, as they are not as attracted to carrion-based bait (Clapperton 1994). In consultation with the approval holder, targeted cat monitoring and control efforts are planned for 2022 to mitigate impacts on the Northern Quoll population.

Toads were abundant during this survey and are known to stay near cannisters consuming insects which account for in part, so many detections. This species has co-habited with Northern Quoll for many generations in this region and are unlikely to have a negative impact on the species. Images are often collected where toads are near the bait cannister hunting for insects and a quoll will come up to the cannister, smell the bait and then leave the camera frame. Further studies where toads are marked for individual identification would be required to understand the time frame for discrete detections in this species.

The parameters assessed for vegetation did not indicate any disparity in condition or structure across control and wind farm sites and it is unlikely the vegetation differs sufficiently (based on the BioCondition parameters) to result in altering population estimates of Northern Quoll.

Overall, the data showed Northern Quoll number and occupancy to be consistent across all sites, with feral cats likely to be the biggest threat at the wind farm to these populations. Further control and monitoring of this pest species may further protect the Mount Emerald Northern quoll population.

As required by the Quoll Outcome Strategy, further monitoring is scheduled for 2023 and 2028.

6.0 Acknowledgements

Thank you to the Australian Wildlife Conservancy (notably Andrew Francis) for allowing continued use of Brooklyn Station as a control site for this study. We acknowledge Willie Brim, Buluwai elder and Jo Martin for their guidance and assistance in organising cadet rangers who assisted on the project.

This work was carried out under Scientific Purposes Permit number SPP-100071533P, PTC-100071531 and Animal Ethics CA 2020/01/1339.

7.0 References

Andersen, A. N., (2012). "Savanna burning for biodiversity: Fire management for faunal conservation in Australian tropical savannas." Austral Ecology **37**(6, Sp. Iss. SI): 658-667.

Burnett, S. (1997). "Colonising cane toads cause population declines in native predators: reliable anecdotal information and management implications." Pacific Conservation Biology **3**: 65-72.

Burnett, S., Piza-Roca, C., and Nugent, D. (2019). Mt Emerald Wind Farm Fauna Monitoring. Sippy Downs, Queensland, University of Sunshine Coast.

Burnett, S., Shimizu, Y., and Middleton, J. (2013). Distribution and abundance of the northern quoll (*Dasyurus hallucatus*) in far north Queensland, Unpublished report to RATCH Australia.

Clapperton, B. K., Eason, C.T., Weston, R.J., Woolhouse, A.D., and Morgan, D.R. (1994). "Development and testing of attractants for feral cats, *Felis catus* " Wildlife Research **21**(4): 389-399.

Covacevich, J. and M. Archer (1975). "The distribution of the cane road Bufo marinus in Australia and its effects on indigenous vertebrates." Memoirs of the Queensland Museum(17): 305-310.

Diete, R., et al. (2016). "Ecology and conservation of the northern hopping-mouse (*Notomys aquilo*)." Australian Journal of Zoology **64**(1): 376-382.

Eyre, T. J., et al. (2011). BioCondition: A Condition Assessment Framework for Terrestrial Biodiversity in Queensland. Assessment Manual. . Brisbane, Department of Environment and Resource Management (DERM), Biodiversity and Ecosystem Sciences. **Version 2.1.**

Fiske, I., Chandler, R. (2011). "unmarked: An R Package for Fitting Hierarchical Models of Wildlife Occurence and Abundance " Journal of Statistical Software **43**(10): 1-23.

Hill, B. and S. Ward (2010). National recovery plan for the northern quoll - *Dasyurus hallucatus*. Palmerston, Department of Natural Resources, Environment, The Arts and Sport.

Niedballa, J., Courtiol, A., and Sollmann, R. (2017). "camtrapR: Camera Trap Data Management and Preparation of Occupancy and Spaital Capture-Recapture Analyses." from http://CRAN.R-prokect.org/package=camtrapR.

Starr, C. and N. Waller (2017). Rapid Biodiversity Survey on Caloola Station, Cape York. Mareeba, Australia, Northern Gulf Resource Management Group**:** 30.

Starr, C., et al. (2016). South Endeavour Nature Refuge Biodiversity Survey Report. Mareeba, Northern Gulf Resource Management Group**:** 52.

Woinarski, J. C. Z., et al. (2014). The Action Plan for Australian Mammals. Australia, CSIRO Publishing.

Woinarski, J. C. Z., et al. (2011). "The disappearing mammal fauna of northern Australia: context, cause and response." Conservation LEtters **4**: 192-201.

Woinarski, J. C. Z., et al. (2008). Surviving the toads: patterns of persistence of the northern quoll (*Dasyurus hallucatus*) in Queensland. Palmerston, Report submitted to the Natural Heritage Trust Strategic Reserve Program, as a component of project 2005/162: Monitoring & Management of Cane Toad Impact in the Northern Territory.

B. BIRD AND BAT COLLISION MONITORING REPORT

Bird and Bat Collision Mortality Report

Mount Emerald Wind Farm (2020-2021)- Year 2

4 elements

Bird and Bat Collision Mortality Report

Revision History

Version	Purpose	Issued by	Date	Reviewer	Date
1	Draft	C Starr	19/3/2022	M Brown	22/03/2022
2	Final	C Starr	28/03/2022	M Brown	29/03/2022

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Contents

1.0 Summary

This report provides analysis from a bird and bat mortality study, which assessed the benefit of wind speed curtailment from 2020-2021 on the Mount Emerald Wind Farm (MEWF), North Queensland. The project was primarily interested in the impact of the wind farm, and subsequent benefits of curtailment on two key species, the Spectacled flying fox (*Pteropus conspicillatus)* and Bare-rumped sheathtail-bat (*Saccolaimus saccolaimus*). In the first year of the study, fatality estimates were measured with turbines set to a Phase 1 curtailment, where rotors did not turn between 0 and 3 m/s wind speed. In the second year of the study, 50% of the turbines were left at the Phase 1 curtailment, and 50% were set so rotors did not turn between 0 and 4.5 m/s (Phase 2). Some data was collected during 2019, however it was excluded from the analysis in this report due to inconsistent establishment of curtailment across the site. In year one of the study, three Spectacled flying fox were located during radial surveys, resulting in a 95% confidence that fewer than 13 were struck during the study period. In year two, only one Spectacled flying fox was found, resulting in 95% confidence that fewer than 10 individuals were lost across the year. 100 individual other bat species were located in year one, with the simulations predicting with 95% confidence that fewer than 454 were struck. In year two, 67 other bat species were located during year two surveys on site, resulting in a 95% confidence that less than 307 individuals were lost. No Bare-rumped sheathtail bat were found in either year of the study on the site. There were insufficient data to determine if a significant difference in modelled distributions of fatality in the Spectacled flying fox occurred across years, due to extremely low find numbers. When considering all other identified bat species and the parameters collected across the survey periods, and assuming the model assumptions hold, the data indicates the true numbers lost in year one was higher than in year two to a statistically significant degree. However, causation for this difference could be attributed to many factors (e.g., temporal change in bat behaviour, decline in populations overall, seasonality, etc), and based on separate analysis was not associated with the turbine curtailment settings.

To explicitly determine the differences in fatality resulting from Phase 1 and Phase 2 curtailment, the data was further analysed using a Before-after Control-impact (BACI) generalised linear model. The low operational impacts on the relevant species meant that the data set was too small to singularly draw conclusions, so an adapted methodology assessed changes in impacts across all bat species. The analysis identified no significant difference in mortality between the 3 m/s and 4.5 m/s cut in scenarios. Despite intensive field work and data collection efforts for this study, study limitations existed in efficiency and sample size, which affected the power analysis.

This is the first regional study of bird and bat mortality during wind farm operations in North Queensland. The results indicate the need for further consideration of the methodology to account for the low carcass numbers in the area, and the implications for statistical analysis. Deployment of detection dogs to carry out radial searches, or modification of human surveyor times may prove beneficial for increasing the power analysis for future studies. Further, understanding the bird and bat species most affected by turbine strike will also be important to best mitigate around those species longer term for this region, where several wind farms are locally under various stages of approval and construction. Our data indicates that the strike rates of the two target species on Mount Emerald Wind Farm are extremely low at this time, and curtailment is unlikely to be required to reduce fatality at this site.

2.0 Introduction

Wind energy development has expanded rapidly over the last three decades, with numerous studies investigating how to estimate true fatality, and what mitigation strategies may reduce the impact of turbine operations on birds and bats. Studies in southern parts of Australia have shown collision as the primary form of fatality (Baerwald et al. 2008), and to a lesser extent barotrauma (Grodskey et al. 2011; Rollins et al. 2012). In some locations, some bat species were observed to be attracted to wind turbines (e.g., Cryan et al. 2009), foraging near and within the rotor plane (Horn et al. 2008). In Tasmania, mortalities primarily occur seasonally, with tree roosting bats with a high wing aspect ratio that forage in the open air at high altitude identified to be most susceptible (Hull and Cawthen 2012). Operational curtailment has shown positive results in some places to reduce bat mortality (e.g., Arnett et al. 2011, 2013; Behr et al. 2017; Hayes et al. 2013), however the method has appeared less successful with reducing bird strikes (Smallwood et al. 2017). These data are yet to be available for wind farms in North Queensland and are required to best mitigate for bird and bat populations susceptible to turbine strike.

This work follows the recommendations of the approved *'Implementation plan for two species of bats at Mount Emerald Wind Farm*' (BIOSIS 2018), meeting the requirements of Condition 13 of approval for MEWF under the provisions of the EPBC Conservation Act 1999. The concept of impact on an 'ecologically significant proportion' of a population has been elaborated in the *Draft referral guideline for 14 birds listed as migratory species under the EPBC ACT* (Commonwealth of Australia 2015) and may be useful for establishing what is considered a significant impact for the two-priority species at Mount Emerald, as well as setting performance criteria for the assessments. This draft identifies in terms of individual animals, annual mortality which meets or exceeds 1% of the population would cause significant impact to the species. Further, it suggests any impact which met or exceeded 0.1% of the population requires further investigation and may be subject to mitigation. Therefore, for Mount Emerald the implementation plan (BIOSIS 2018) has identified that for these two species mortalities of ≥1% would be significant, and any impact ≥0.1% would instigate a management response. Recent population estimates for the Australian populations for these species are: greater than 10,000 individuals for Bare-rumped sheathtail bat (Woinarski et al. 2014); and 44,000 individuals for Spectacled flying-fox following a heat event in October 2018 (Westcott 2019). Using these coarse estimates, annual thresholds must not exceed 10 Bare-rumped sheathtail bats and 44 Spectacled flying foxes (BIOSIS 2018). If these numbers are reached/exceeded a management response would be instigated.

Therefore, this research aimed to:

1. Establish estimates of how many bird and bat fatalities occur due to collision/barotrauma at the Mount Emerald WF;
2. Assess generated collision estimates in relation to pre-established performance measures for Spectacled flying fox and Bare-rumped sheathtail bat (i.e. not exceeding ≥ 0.1 % of current population estimates); and
3. Determine if there is a significant mitigative benefit at reducing collision fatalities between Phase 1 and Phase 2 curtailment at Mount Emerald Wind Farm.

3.0 Collision mortality

3.1 Experimental Design

3.1.1 Carcass surveys

Field surveys for carcasses were carried out by ecologists across all 53 turbines in the 'fall zone'. Huso and Dalthorp (2014) identified that when assessing numerous carcass survey models, carcass density reached zero at approximately 70 m horizontally from the turbine base, and this radius was used in the study. Surveys were carried out on day 1, 4 and 28 of each month, for 12 consecutive months across Phase 1 and again in Phase 2. One month prior to commencing the study, each turbine was swept to remove any carcasses before starting the surveys, to account for animals which have perished prior to the monthly survey schedule in the first sampling period. Inaccessible areas were surveyed with binoculars.

Data on the frequency of collision is necessary for use in extrapolation to estimate total fatality. Therefore, a 3-day interval between two searches at the beginning of the search cycle was designed to provide information on collision frequency to feed into the model- as there is a high probability a new carcass is found on day 4 must have collided in the preceding three days. Animals detected on day 1 were marked by surveyor tape/paint to identify them as an old animal on subsequent survey days. There was a 27-day interval before the next round of sampling (day 28). The survey on day 28 became day one on the next survey cycle. This cycle was repeated across the year.

Records of all birds and bats were logged; however, implications of collisions regarding management responses relate only to Bare-rumped sheathtail bat and Spectacled flying-fox. Photographs were taken of all animals recorded in the study. All threatened taxa were collected on day 4 and stored in a deep freezer on-site. The mortality estimate is based on a dated list of turbine surveys. The survey frequency is summarised in **Table 1**.

Table 1 Number of surveys per month

Date	No. surveys
2021 Jan	158
2021 Feb	106
2021 Mar	159
2021 Apr	104
2021 May	104
2021 Jun	100
2021 Jul	106
2021 Aug	106
2021 Sep	132
2021 Oct	186
2021 Nov	105
2021 Dec	106

3.1.2 Carcass persistence trials

Carcasses of small microbats are unlikely to persist in the field for long periods; therefore, extrapolation is required from those detected to estimate total deaths more accurately. Carcass persistence trials were carried out to determine a 'correction factor' in the analysis. These were carried out in February 2019, March 2019, August 2019, September 2019, October 2020, November 2020, April 2021, September 2021 and October 2021. This provided datasets across seasons. Due to a large die off in Spectacled flying fox prior to our study in year one, we were able to collect and utilise real carcasses for the study in the first year. In subsequent years, chicken carcass was used as a proxy. Given the difficulty in acquiring microbats of similar size to Bare-rumped sheathtail bat, we had to utilise surrogates, and young rats and chicken wings were used on the site. These were all marked to ensure they were not confused with animals killed by turbines, or from the site.

Persistence trials were carried out for 28 days at 20 representative turbines and utilised 10 microbat surrogates and 10 flying foxes/surrogates for each sampling period. Camera traps were placed in front

of the carcasses and set to record all movement and take a photograph every hour (day and night). Censored analysis must be used to account for carcasses that persist longer than the trial period (Klein and Moschberger 2003).

To improve the likelihood of detecting any moved carcass, these surveys were undertaken one week prior to the next targeted carcass survey. This enabled locating any moved animals so they are not lost from the trial and can be reused/placed. Each trial ran for one month, with an ecologist checking all stations are operational at 14 days. Removed carcasses which could not be found were replaced on day 14 with a new carcass to maximise the data collected. This data was used for calculation of average carcass persistence times for the collision estimates.

Survival analysis (Kaplan and Meir 1958) were used to determine the average time till complete loss from a scavenge. Analysis by Symbolix used a log-normal distribution to describe survival time. AIC suggested that the most parsimonious model was one that differentiated between Flying fox and Sheathtail bat proxies, so the data were treated separately in the mortality estimation.

3.1.3 Searcher Efficiency Trials

Correction factors are required in the analysis to account for searchers not always finding all carcasses. This was done through blind trials, where carcass proxies are placed prior to a search (minimum of 10 flying foxes, 10 microbats at a minimum of 10 turbines). Five searcher trials were carried out during the study, these occurred in February 2019, December 2019, May 2021, June 2021 and October 2021. This captured efficiency during both wet and dry season months. The number of detected animals by the surveyors was used to develop correction factors for the final analysis.

3.1.4 Curtailment

In the first year of operation, all turbines were set to Phase 1 (curtailment = 0 and 3m/s wind speed). In the second year (2021) 50% of the turbines were left at the Phase 2 setting, with 50% set to Phase 2, where rotors did not turn between 0 and 4.5 m/s wind speed (**Figure 1**). Fatality comparisions are assessed between curtailment settings, with focus on the two target species.

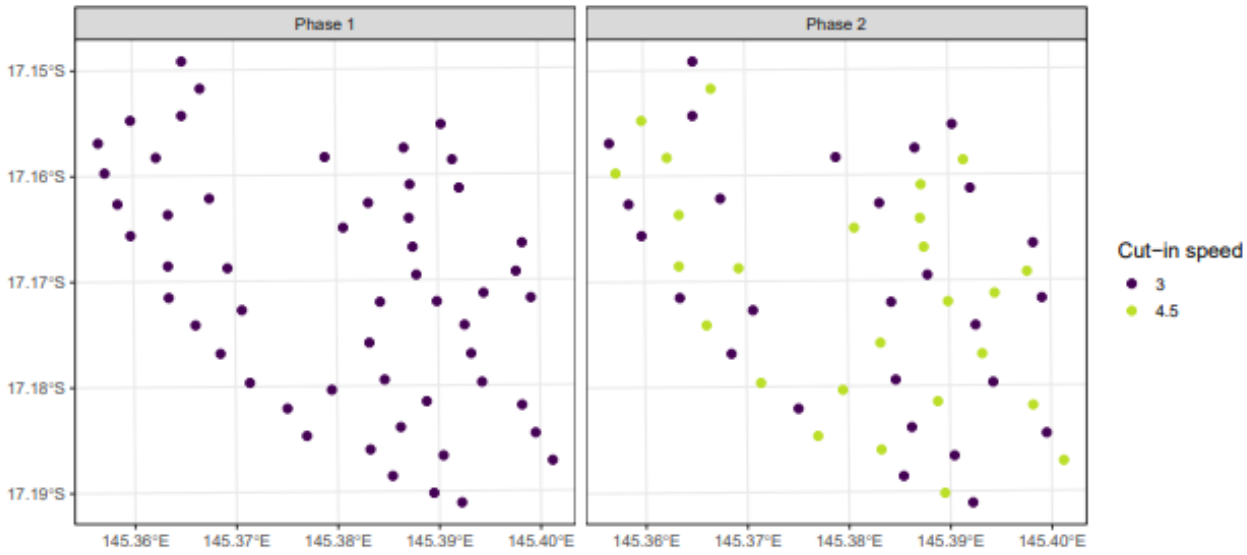


Figure 1. Cut-in speeds under Phase 1 and Phase 2. The dots show turbine locations at Mt Emerald Wind Farm.

3.2 Analysis

Annual collision mortalities were calculated by Symbolix Pty Ltd for the two key threatened species accounting for carcass persistence times relative to search interval and searcher efficiency. We provide their detailed methodology below.

To estimate the mortality loss at a given wind farm site (in a way that is comparable with other facilities) we accounted for differences in survey effort, searcher, and scavenger efficiency by using a Monte-Carlo simulation.

The model assumptions are as follows:

- There were 53 turbines on site,
- Search frequency for each turbine was taken from an actual list of survey dates,
- Mortalities were allowed to occur from 2020-01-01 to 2021-12-31,
- Bats are always on-site during this survey,
- Finds are random and independent,
- There was equal chance of any turbine individually been involved in a collision,
- We assumed a log-normal scavenger shape,

- We took scavenge loss and search efficiency rates as outlined above,
- All 53 turbines were surveyed. Each turbine was surveyed monthly with a pulse survey three days after the initial survey. The search area consisted of the hardstand and road area within a 70 m radius (covering 99% of fall zone),
- Due to complex spatial regions of ground types in the search areas for different turbines, and differences in searcher efficiency across sites we calculated a weighted average detection probability,
- This depended on the area of hardstand and vegetated regions and the fall zone distribution over the searched area (using fall zone estimates from the algorithm in Hull and Muir (2010)). The weighted average detectability was 50% with a 95% confidence interval. This accounted for searcher efficiency, spatial ground type regions, and fall zones distribution.

3.2.1 Mortality estimation

With estimates for scavenge loss and searcher efficiency, we then converted the number of flying fox and other bat carcasses detected into estimates of overall mortality at Mount Emerald Wind Farm from 2020-01-01 to 2021-12-31 (we allow for collisions to occur up to a month prior to the first survey). The mortality estimation is done via Monte-Carlo simulation. We used 25,000 simulations with the survey design simulated each time. Random numbers of virtual mortalities were simulated, along with the scavenge time and searcher efficiency (based on the measured confidence intervals). The proportion of virtual carcasses that were "found" was recorded for each simulation. Finally, those trials that had the same outcome as the reported survey detections were collated, and the initial conditions (i.e. how many true losses there were) reported on. The complete set of model assumptions can be viewed in the attached Symbolix reports.

3.2.2 Curtailment Impact Analysis

The impact of altering curtailment were assessed using a Before-After Control-Impact (BACI) linear model. Before-After refers to Phase (1-before; 2=after), whilst Control-Impact refers to the curtailment group. The Control group stayed at 3 m/s cut in, while the Impact group started at 3 m/s cut-in (Before), then moved to 4.5 m/s (After). The response variable in the BACI model is the number of finds per survey. We therefore test the hypothesis that interaction term between Impact group and After period is non-zero.

The models were fit using R stats (R Core Team 2021) and MASS (Venables and Ripley 2002) packages, and then used a DHARMa package (Hartig 2021) to assess goodness of fit. Based on the DHARMa analysis, a Poisson distribution was selected for Flying foxes, and a Negative Binomial distribution for the bat model.

3.2.3 Power analysis and assumptions

Power analysis explains the magnitude of effect wed expect to see with this design, under a variety of scenarios. This is demonstrated by **Figure 2**. This identifies that if the find rate is 1 find per 100 surveys, the power at best is 15%. With 5 finds per 100 surveys, there is a 30-40% chance of picking up a significant interaction. The best-case scenario then is if we can have 10 finds per 100 surveys which reaches 60-80% power. This means a non-significant result can be due to a low baseline find rate, a small reduction in find rates, a large Before-after effect, or that there simply is no effect. If there is indeed a true difference due to curtailment, it would need to have a sizeable reduction (50% at least), or the original baselines need to be quite high.

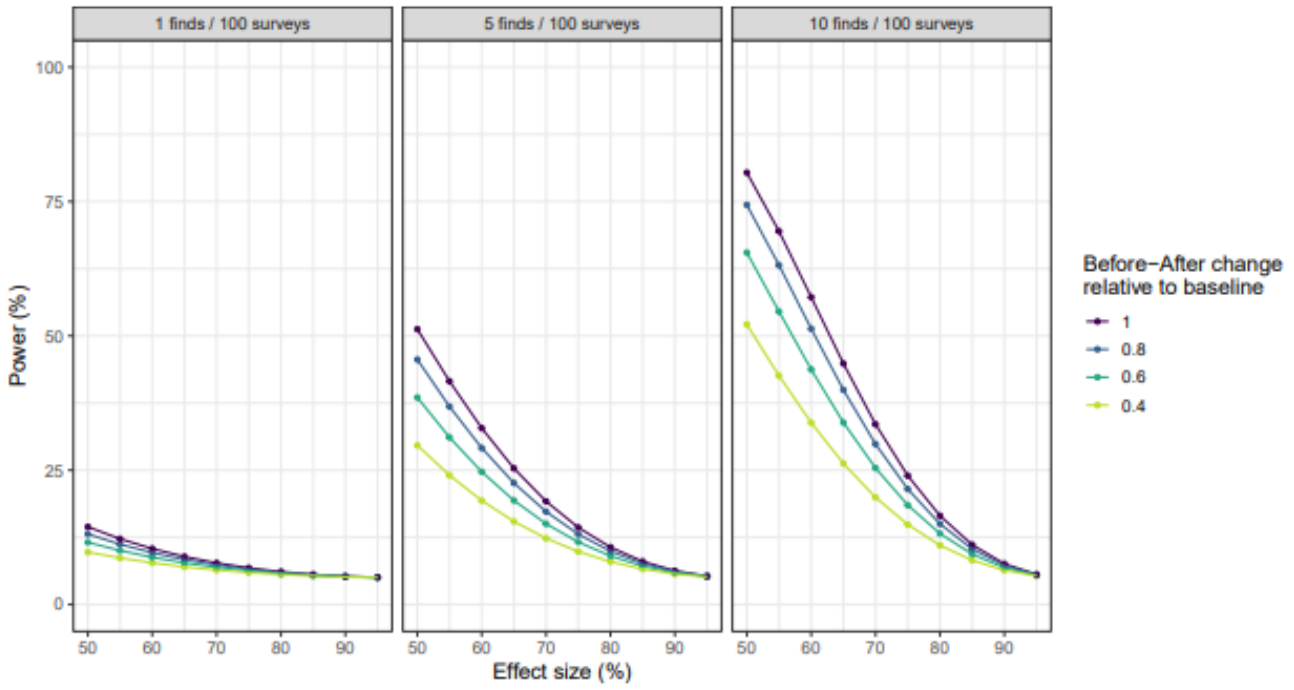


Figure 2 Power curves under a variety of scenarios.

Turbines were additionally mapped to ensure no latent spatial pattern- none was found. The distribution of hardstand and vegetated areas in search zones were also checked for patterns, and none were found. The searcher efficiency data were checked to ensure the After: Impact interaction

wasn't significantly different, and it were not (p=0.15). We also checked the scavenger efficiency data to ascertain if there were an After: Impact interaction, there was not (p=0.41). Due to the low count, it was uncertain if there were a change in species composition across the years, however we assume there were not for this analysis.

4.0 Results

4.1 Searcher Efficiency

We found no evidence that surveyor efficiency differed across trial periods, or between bat and flying fox proxies. Searcher efficiency rates did however differ across vegetation to hardstand and rock face. To account for this in the analysis we used shapefiles to determine average detection probability across these differing ground structures.

Bat detectability in vegetated areas is 17%, with a 95% confidence interval of 11%, 24%. On hardstand and rockface, detectability was 65%, with a confidence interval of 54%, 75% (**Table 2**).

Table 2 Detection efficiency for bats.

Variable	Vegetation	Hardstand
Number found	25	59
Number placed	150	91
Mean detection proportion	0.17	0.65
Detectability lower bound (95% confidence interval)	0.11	0.54
Detectability upper bound (95% confidence interval)	0.24	0.75

4.2 Scavenger Efficiency

Scavenge rates for chicken frames and chicken carcass appeared to be much higher than Spectacled flying fox carcass on the site, and therefore the data using proxies for flying fox were removed from the analysis. **Figure 3** shows the survival curve fitted to the Flying fox and Bare-rumped sheathtail bat proxies. The survival curves (solid line) show the estimated proportion of the sets remaining at any given time. The shaded proportions are the 95% confidence intervals on the estimates. We expect around 31% to 53% of flying-fox carcass to remain after 10 days, with the expectation sitting

around 40%. For Bare-rumped sheathtail bat proxies, we expect around 18% to 36% to remain after 10 days, with the expectation around 25%.

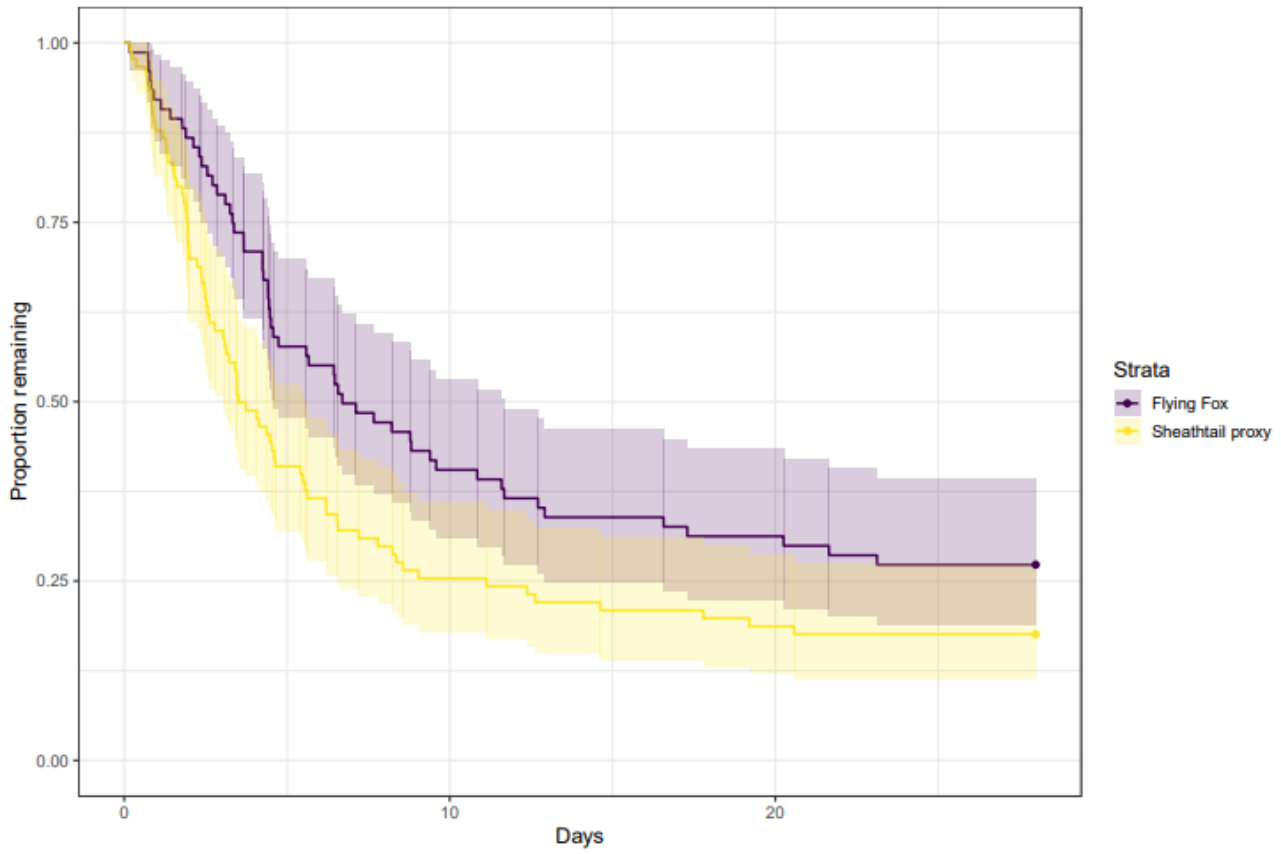


Figure 3. Combined survival curves for Flying foxes and Bare-rumped sheathtail bat proxies, with 95% confidence interval (shaded).

The median time to total scavenger loss is 9.1 days (95% confidence 6.4-12.9), and for sheathtail bat proxies 5 days (confidence interval 3.6-6.8).

4.3 Mortality

After running the simulation Symbolix investigated the distribution of mortalities that could have resulted in the actual numbers found during the surveys. During 2020/2021 one Spectacled flying fox was located on site, and 167 other bat species (**Table 3**)**.** Note that although we are focussing on bat mortalities, we also report bird mortalities for completeness. Some carcasses were quite decomposed, and at times identification were not possible. The most commonly found species during surveys were the Northern freetail bat (*Chaerephon jobensis*), followed by the Little red flying fox (*Pteropus scapulatus*) (**Table 3**).

Table 3 Carcasses found during formal surveys (year two)

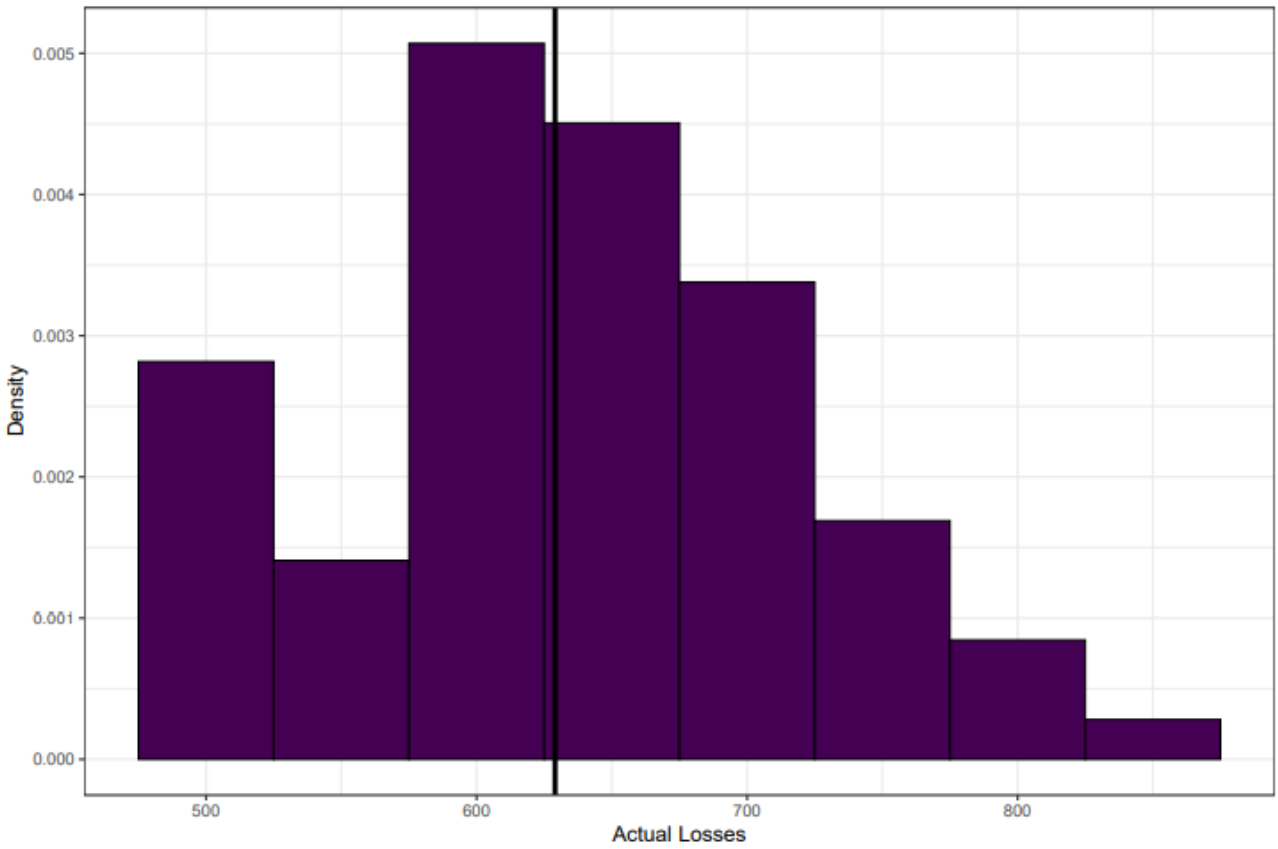
Species	Bat	Bird
Northern freetail bat *Chaerephon jobensis*	105	
Little red flying fox *Pteropus scapulatus*	29	
White-striped freetail bat *Tadarida australis*	7	
Bent-winged bat *Miniopterus sp,*	9	
Spectacled flying fox *Pteroptus conspicillatus*	1	
Unidentifiable flying fox	1	
Yellow-bellied sheathtail-Bat *Saccolaimus flaviventris*	6	
Unidentified microbat species	6	
Little bent-wing bat *Miniopterus australis*	2	
Bat fragments	1	
Troughton's sheathtail bat *Taphizous troughtoni*	1	
Wedge-tailed eagle *Aquila audax*		4
Brown falcon *Falco berigora*		6
Magpie lark *Grallina cyanoleuca*		1
Australian magpie *Gymnorhina tibicen*		1
Fork-tailed swift *Apus pacificus*		1
Laughing kookaburra *Dacelo novaeguineae*		1
Peaceful dove *Geopelia placida*		1
White-throated needletail *Hirundapus caudacutus*		1
Nankeen kestrel – *Falco cenchroides*		1
Pale-headed rosella *Platycercus adscitus*		2
Tawny frogmouth *Podargus strigoides*		1
Rufous fantail *Rhipidura rufifrons*		1
Pied currawong *Strepera graculina*		1
Forest kingfisher *Todiramphus macleayii*		1
Sacred kingfisher *Todiramphus sanctus*		1
Superb fruit-dove *Ptilinopus superbus*		1
Rainbow lorikeet *Trichoglossus moluccanus*		1
Unidentified bird species.		2

4.3.1 Bat mortality estimation

The estimate of bat mortalities (excluding Spectacled flying fox) is an expectation of 634 and a median of 629. **Table 4** and **Figure 2** display the percentiles of distributions, to show the confidence intervals in the averages. We expect a total loss on the site of approximately 634 bats, with 95% confidence that fewer than 765 were lost in 2020 and 2021.

Table 4 Percentiles of estimated total losses over 2020/21 for bats (excluding Spectacled flying fox)

0%	50% (median)	90%	95%	99%	99.9%
482	629	730	765	828	861

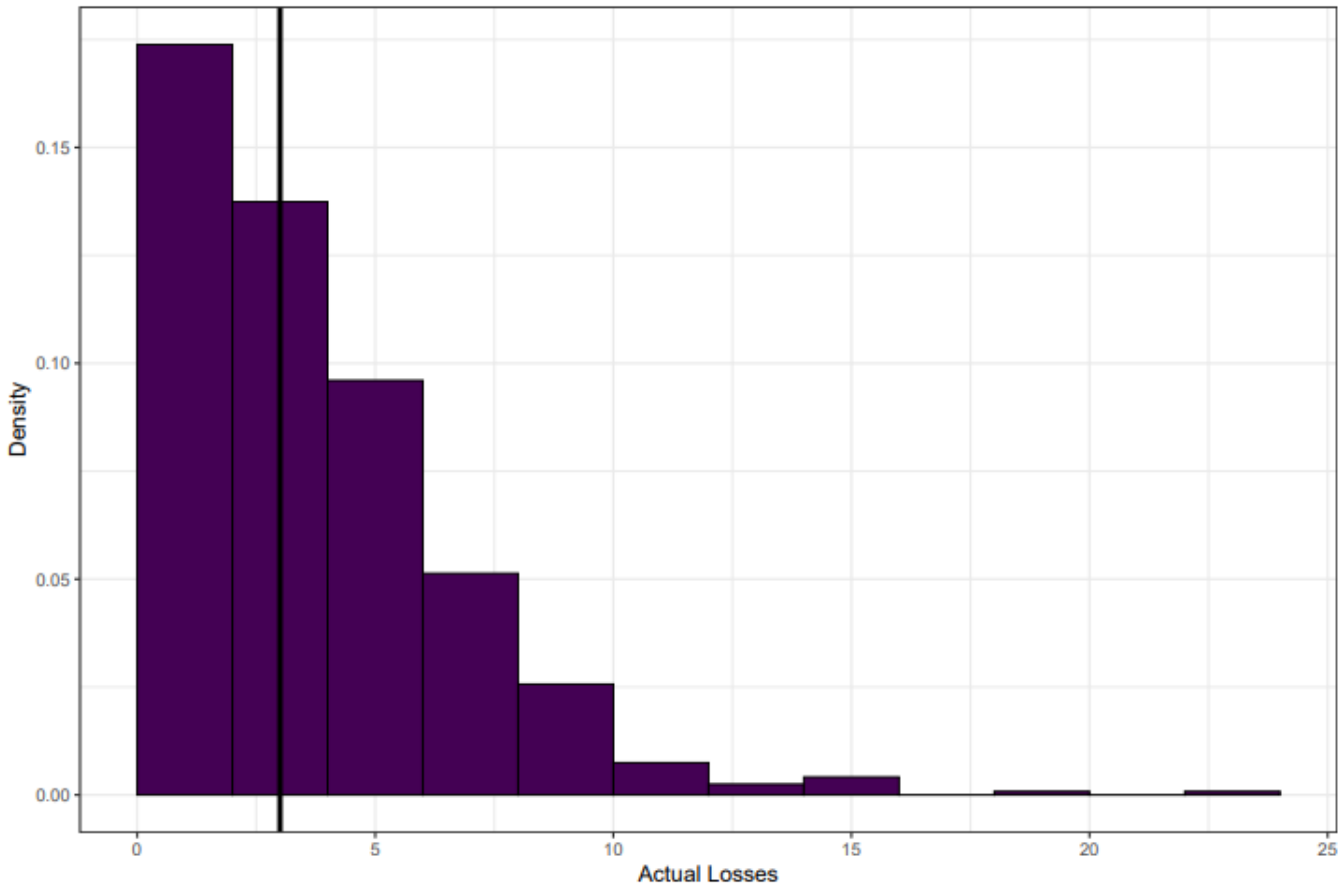


Histogram of the total loss's distribution over 2020/21 for bats (excluding Spectacled flying fox), given 167 were detected on site. The black solid line shows the median.

Only one Spectacled flying fox was located on the site during the second year, resulting in an expectation of four, and a median loss of three Spectacled flying foxes on the site over the two years. **Table 5** and **Figure 6** display percentiles of distributions, to show confidence intervals. We are 95% confident that less than 10 individuals of this species were lost during 2020/2021.

Table 5 Percentiles of estimated total losses over 2020/21 for Spectacled flying fox

0%	50% (median)	90%	95%	99%	99.9%
1	3	8	10	15	21



Histogram of the total loss's distribution over 2020/21 for Spectacled flying fox, given one was found on site. Black solid line shows the median.

4.3.2 Comparison across years

100 bats (not Spectacled flying fox) were found in 2020, with 95% confidence less than 454 individuals were lost. In 2021, this was 67, with 95% confidence less than 307 were lost. The distribution shifted right in year one, compared to the distribution in year two (D= 0.89, greater than D*=0.35 at 0.05 significance level). This implies the total number of losses in bats were significantly higher in year one, than year two.

Due to the extremely small find rates in Spectacled flying fox, we were unable to compare numbers across the years.

4.3.3 Before-After Control-Impact Modelling

As only three Spectacled flying fox were found, there were insufficient data for the BACI model. No Bare-rumped sheathtail bats were found, and they also could not be modelled. Therefore, to analyse

the data as best as possible, all flying foxes were used as a proxy for Spectacled flying fox, and all other bats were used as a proxy for Bare-rumped sheathtail bat.

The interaction term of interest was non-significant for both proxy sets (**Table 6** and **Table 7**).

Table 6 Coefficient estimates for the Flying fox model. Note that the mean Estimate and SE are presented on log-scale.

Term	Estimate	SE	z-score	p-value
BA = Before, CI = Control	-4.50	0.30	-15.0	<0.001
BA = After, CI = Control	-5.00	0.45	-11.0	<0.001
CI=Impact	0.68	0.37	1.8	0.066
BA = After, CI = Impact	-0.86	0.77	-1.1	0.26

Table 7 Coefficient estimates for the bat model. Note that the mean Estimate and SE are presented on log-scale.

Term	Estimate	SE	z-score	p-value
BA = Before, CI = Control	-3.10	0.17	-18.00	<0.001
BA = After, CI = Control	-3.10	0.20	-16.00	<0.001
CI=Impact	-0.13	0.25	-0.53	0.6
BA = After, CI = Impact	-0.13	0.39	-0.33	0.74

5.0 Discussion

Bird and bat carcasses located on wind farms have raised concerns about the impacts of wind power development on vulnerable species. This has instigated intensive monitoring protocols like the one established in this study to ascertain the direct impact on local species, and the potential mitigative actions which may be available to reduce strike rates. Strike rates for the two key species were identified to be under the threshold to instigate a management response and were low with no Bare-rumped sheathtail bats found, and 95% confidence that less than 10 Spectacled flying fox were struck on the site from 2020-2021. Strike rates of more common species were approximately 634 individuals, with 95% confidence this number across 2020 and 2021 fell below 765 individuals. Some form of on-going monitoring will be required to ensure these numbers do not shift across years, notably with the threatened Spectacled flying fox.

Studies have identified significant reduction in strike rates of bats through wind speed curtailment using BACI (Smallwood et al. 2020). Unfortunately, limited carcass finds in this study reduced the power analysis to ascertain the benefit of two phases of curtailment on birds and bats at Mount Emerald WF. Future assessments in this region on new wind farms may use these findings to modify the way in which they assess curtailment, which may include modification to searcher efficiency. Shorter search intervals (Smallwood et al. 2017) and use of scent-detection dogs (Arnett et al. 2009; Mathews et al. 2013) have greatly improved fatality detection in other sites. Skilled scent-detection dogs are known to locate 95% of placed bats, and 91% of placed birds in efficiency trials (Smallwood et al. 2020), in comparison to human surveyors in this study which located 17% of carcasses placed in vegetated areas, and 65% on hardstands or rock faces. This is likely to translate into increased species lists for the site, as well as higher relative precision of fatality estimation. Also, human searcher detection is known to decline based on distance to the turbine during radial sweeps, which is not observed in dog detection on wind farms (Smallwood et al. 2017).

Alongside the need for improved detection rates, more research is likely required to better quantify undetected proportions of fatalities in estimation used within Australia (Smallwood et al. 2020). Our study identified significant differences in scavenger persistence of Spectacled flying fox carcass with proxies during the persistence efficiency trials, indicating these proxies may not be representative in the modelling of true persistence, likely to influence the final modelled estimation.

The Spectacled flying fox has undergone significant decline following heat waves in 2018. This compounded several threats to the species, such as habitat loss, entanglement, tick paralysis, genetic disorders, illegal shooting, net entanglement, and agricultural pesticides (Westcott 2019). Signs of

any larger-scale strikes to this species in future years at the site may instigate a management response and will require some form of ongoing observation. There was no record of Bare-rumped sheathtail bat during any field surveys during this study. Extensive, targeted anabat surveys of the Bare-rumped sheathtail bat (4 Elements 2022) failed to detect the species in 2021-2022 leading to the conclusion that there is unlikely to be an active population on or nearby the site. Habitat loss, competition for tree hollows, disease and frequent fire are identified as the major threats to the species, and its ecology and behaviour is not well understood (Schulz and Thomson 2007). Its small size (48-55 g (Hall 1995)) would not have prevented its detection on site if struck by turbine blades, as the most frequently located species during carcass surveys were the Northern freetail bat, which weighs a mere 16-28 gm.

This work provides an important baseline of local species which are impacted from turbine strike, alongside other threatened taxa. Any future studies should carefully consider the most appropriate methodology and should consult with statisticians familiar with these datasets. This first study in the region may guide the design of wind farm fatality estimation which is locally suitable, based on strike rates as part of bird and bat implementation plans in North Queensland.

6.0 References

Arnett et al. (2009) *Effectiveness of changing wind turbine start-up speed to reduce bat fatalities at wind facilities*, report to the Bats and Wind Energy Cooperative, Bat Conservation International, Austin, Texas, USA.

Arnett E, Huso M, Schirmacher M, and Hayes J (2011) 'Altering turbine speed reduces bat mortality at wind-energy facilities' *Frontiers in Ecology and the Environment* **9**: 209–214.

Arnett E, Johnson G, Erickson W and Hein C (2013) 'A synthesis of operational mitigation studies to reduce bat fatalities at wind energy facilities in North America', Report to The National Renewable Energy Laboratory, Golden, Colorado, USA.

Baerwald E, D'Amours G, Klug B and Barclay R (2008) ''Barotrauma is a significant cause of bat fatalities at wind turbines.'' *Current Biology*, 18: R695–696

BIOSIS (2018) Implementation Plan for two species of bats at Mount Emerald Wind Farm, Queensland. Report for Mount Emerald Wind Farm Pty Ltd, Melbourne, Biosis Pty Ltd.

Behr O, Brinkmann R, Hochradel K, Mages J, Korner-Nievergelt F, Niermann I, Reich M, Simon R, Weber N, and Nagy M (2017) 'Mitigating Bat Mortality with Turbine-Specific Curtailment Algorithms: A Model Based Approach, In *Wind Energy and Wildlife Interactions* (pp. 135–160), Springer International Publishing. https://doi.org/10.1007/978-3-319-51272-3_8

Commonwealth of Australia (2015) '*Draft referral guideline for 14 birds listed as migratory species under the EPBC Act*', Australia.

Cryan P and Barcaly R (2009) 'Causes of bat fatalities at wind turbines: hypotheses and predictions. *Journal of Mammalogy*' **90**: 1330–1341

Grodsky S, Behr M ,Gendler A, Drake D, Dieterle B, Rudd R and Walrath N (2011) 'Investigating the causes of death for wind turbine-associated bat fatalities.'' *Journal of Mammalogy*, **92**: 917–925

Hall L (1995) 'Bare-rumped Sheathtail bat Saccolaimus saccolaimus', in Strahan R (eds) T*he Mammals of Australia*, Reed Books, Chatswood, NSW.

Hartig F (2021) DHARMa: Residual Diagnostics for Hierarchical (Multi-Level / Mixed) Regression Models. https://CRAN.R-project.org/package=DHARMa.

Hayes M (2013) 'Bats killed in large numbers at United States wind energy facilities' *BioScience,* **63**: 975–979.

Horn J, Arnett E and Kunz T (2008) 'Behavioral responses of bats to operating wind turbines', *Journal of Wildlife Management*, **72**: 123–132.

Hull C and Muir S (2010) 'Search areas for monitoring bird and bat carcasses at wind farms using a monte-carlo model', *Australasian Journal of Environmental Management,* **17(2)**: 77-87.

Hull C and Cawthen L (2012) 'Bat fatalities at two wind farms in Tasmania, Australia: bat characteristics, and spaital and temporal patterns' *New Zealand Journal of Zoology*, **40**: 1, 5-15.

Huso M and Dalthorp D (2014) 'Accounting for areas in estimating wind turbine-caused fatality' *The Journal of Wildlife Management*, **78**: 347-358.

Kaplan E and Meir P (1958) 'Nonparametric estimation from incomplete observations' *Journal of American Statistical Association*, **53**: 457-481.

Klein J and Moschberger M (2003) 'Survival analysis: techniques for censored and truncated data', New York, Springer.

R Core Team (2021) *R: A Language and Environment for Statistical Computing.* Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/.

Rollins K, Meyerholz D, Johnson G, Capparella A and Loew S (2012) 'A forensic investigation into the etiology of bat mortality at a wind farm: barotrauma or traumatic injury?' *Veterinary Pathology*, **49:** 362–371

Schulz M and Thomson B (2007) *National recovery plan for the bare-rumped sheathtail bat Saccolaimus saccolaimus nudicluniatus,* report to Department of the Environment and Water Resources, Canberra, Queensland Parks and Wildlife Service, Brisbane.

Smallwood K, Neher L and Bell D (2017) 'Siting to minimize raptor collisions: an example from the repowering Altamont Pass Wind Resource Area', in Perrow M (eds) *Wildlife and wind farms – conflicts and solutions*, Volume 2. Pelagic Publishing, Exeter, United Kingdom.

Smallwood K and Bell D (2020) 'Effect of wind turbine curtailment on bird and bat fatalities' *The Journal of Wildlife Management,* **84 (4)**: 685-696.

Smallwood K and Bell D and Standish S (2020) 'Dogs detect larger wind energy effects on bats and birds' *The Journal of Wildlife Management* 1-13.

Venables W and Ripley B (2002) *Modern Applied Statistics with s. Fourth*, New York: Springer.

Westcott D (2019) 'The National Flying-Fox Monitoring Program Report on the Nov 2018 Survey' Retrieved 19/03/2022, from https://www.environment.gov.au/system/files/pages/391f5fed-e287-4dd3-85ac-640037926ef5/files/flying-fox-nov2018-count-report.pdf.

Woinarski J et al (2014) *The Action Plan for Australian Mammals*, CSIRO Publishing, Australia.

C. OFFSET AREA MONITORING REPORT

Offset Monitoring Program – Mount Emerald Wind Farm

RATCH Australia Corporation Limited

4 elements

Offset Monitoring Program – Mount Emerald Wind Farm

RATCH Australia Corporation Limited

Revision History

Version	Purpose	Issued by	Date	Reviewer	Date
1	Draft	Matthew Hemmings	01/06/2021	Mellissa Brown	27/07/2021

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1.0 Introduction

1.1 Background

The Mount Emerald Wind Farm (MEWF) Offset Site (study site) is located within land described as Lot 22 SP210202 and comprises approximately 434.9 ha (**Figure 1**). It is located immediately to the southeast of the MEWF site at Mutchilba, within the Mareeba Shire Council Area, with vehicle access through Lemontree Drive. The lot tenure is freehold and the primary land use is vacant. The area fringes the Baldy Mountain Forest Reserve and the Herberton Range National Park, via the Herberton Range (Queensland Government 2016).

On 26 November 2016, approval under the provisions of the *Environmental Protection and Biodiversity Conservation* (EPBC) *Act*, was granted to RATCH Australia Corporation Limited (RACL). As a requirement of the EPBC Act approval 2011/6228, as issued by the Federal Department of the Agriculture Water and the Environment (DAWE), a Biodiversity Offset Area was developed to compensate for the clearing of ~73 ha of habitat on the MEWF Project Site. The MEWF Offset site has been designated as a Nature Reserve under the *Nature Conservation Act 1992* by the Queensland Department of Environment and Science (DES).

The MEWF Offset site is located entirely within the Wet Tropics bioregion. It is mountainous with narrow ridges and rocky terrain that are steeply dissected along three dominant ridge lines. The offsets site lies adjacent to the MEWF project site. The majority of the site consists of remnant vegetation with ~192.89 ha consisting of Least Concern vegetation listed under the *Vegetation Management Act 1999* and the remaining ~242 ha listed as Of Concern vegetation.

4 Elements Consulting was commissioned by RACL to conduct biennial ecological monitoring surveys on the MEWF Offset Site. This current report details the results of the fourth fauna survey since 2017. This report has been prepared to comply with the requirements outlined in the Mount Emerald Wind Farm Offset Area Management Plan (RPS 2016), which details monitoring management actions. The data collected in 2016 provided baseline data for future monitoring to be compared against and enables targeted and adaptive management procedures to be implemented to ensure the biological integrity of the biodiversity area is maintained or improved and conserved into the future.

The actions required include:

- Targeted survey of threatened fauna species to determine changes to species diversity on site over time;
- Pest species presence/absence assessment;
- Photo-monitoring points to determine variation over time; and
- Targeted weed surveys.

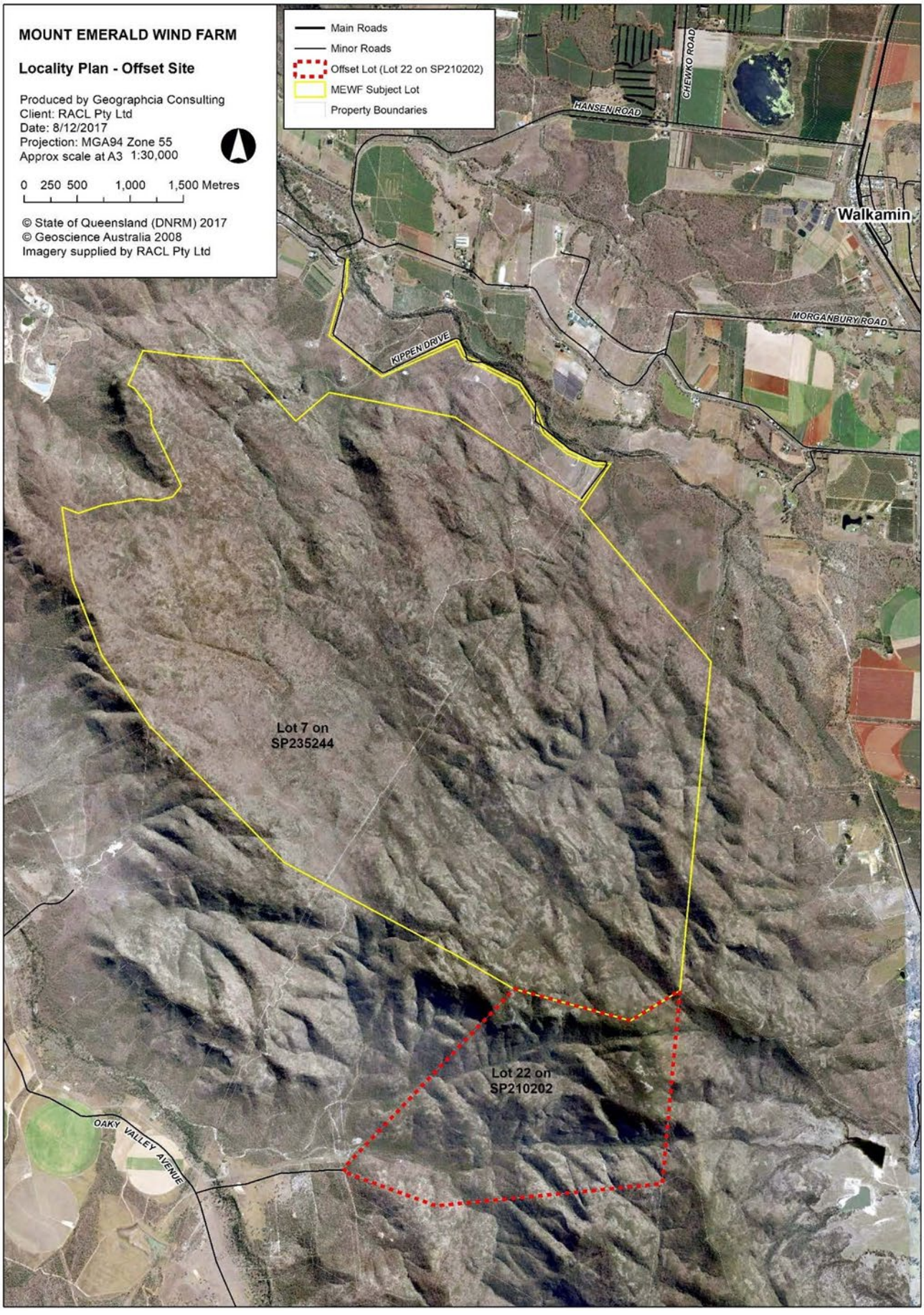

Figure 1 MEWF Offset Location

1.2 Objectives and Outcomes

As identified in the Offset Area Management Plan (RPS 2016), the offset area provides for the long-term protection of habitat for seven threatened species and, through the implementation of adaptive management practices, the quality of the habitat will be improved and maintained over time. The offset area is to be protected in perpetuity as a Nature Refuge. The management plan objectives and outcomes are to:

- Protect remnant vegetation communities within the offset area from degradation;
- Protect native fauna within the offset area from introduced weeds and pest fauna;
- Protect the site vegetation and fauna from wildfires;
- Maintain the ecological condition of remnant vegetation listed as Of Concern and Least Concern under the *Vegetation Management Act 1999* within the Offset area, where the BioCondition Class of 1, for each assessment unit does not change.

This ecological monitoring report presents the methods and results of the 2021 ecological monitoring program at the MEWF Biodiversity Offset Area, including a discussion of the findings and comparisons with the results of the baseline data conducted in 2016. Management recommendations that relate to the current monitoring phase are documented in **Section 5.0**.

1.2.1 Regional Ecosystems:

The Regional Ecosystems (REs) mapped for the offset site are described in **Table 1** and shown on the mapping in **Figure 2**. Baseline surveys in 2016 identified that RE mapping was consistent with ground truthed vegetation assessments.

Table 1 Regional Ecosystems Present Within the Proposed Offset Site

RE	RE Description	VMA[1]	Bio.[2]	Area[3]
7.3.26a	Riverine wetland or fringing riverine wetland. *Casuarina cunninghamiana*, *Eucalyptus tereticornis*, *Lophostemon suaveolens*, *Melaleuca leucadendra*, *M. fluviatilis*, *Buckinghamia celsissima*, *Mallotus philippensis* woodland and forest with an understorey of *Melaleuca viminalis* and *Bursaria tenuifolia*. Fringing forests of larger streams. (BVG1M: 16a).	OC	E	2.63
7.12.7c	Simple notophyll semi-evergreen vine forest. Uplands of the dry rainfall zone. Rhyolite. (BVG1M: 5c).	LC	NCP	1.24
7.12.9	*Acacia celsa* (brown salwood) open forest to closed forest. Foothills, uplands and highlands on granites and rhyolites, of the very wet and wet rainfall zone. (BVG1M: 5d).	OC	OC	1.16

RE	RE Description	VMA[1]	Bio.[2]	Area[3]
7.12.16a	Simple to complex notophyll vine forest, including small areas of *Araucaria bidwillii* (Bunya pine). Uplands and highlands on granites and rhyolites, of the cloudy wet to moist rainfall zones. (BVG1M: 6b).	LC	NCP	9.34
7.12.26a	*Syncarpia glomulifera*, *Allocasuarina torulosa* and/or *A. littoralis* open-forest and woodland. Uplands and highlands, often on steep slopes, of the wet rainfall zone. Granite and rhyolite. (BVG1M: 28e).	LC	NCP	4.41
7.12.26e	*Syncarpia glomulifera* low open forest and low woodland. Uplands on steep rocky slopes, of the moist and dry rainfall zone. Granite and rhyolite. (BVG1M: 28e).	LC	NCP	8.99
7.12.29a	*Corymbia intermedia*, *Eucalyptus tereticornis*, *E. drepanophylla* open forest to low open forest and woodland with *Allocasuarina torulosa*, *A. littoralis*, *Lophostemon suaveolens*, *Acacia cincinnata*, *A. flavescens*, *Banksia aquilonia* and *Xanthorrhoea johnsonii*. Uplands, on granite and rhyolite. (BVG1M: 9c).	LC	NCP	4.60
7.12.30d	Open woodland to open forest (10-20 m tall) mosaic with variable dominance, often including *Eucalyptus cloeziana*, *C. citriodora*, *E. portuensis*, *E. lockyeri*, *C. leichhardtii*, *E. atrata*, *E. pachycalyx*, *E. reducta*, *C. intermedia* and *E. shirleyi*. There is often a very sparse to mid-dense secondary tree layer of *C. abergiana* and/or *C. stockeri*. A very sparse to sparse tall shrub layer may be present and can include *Acacia flavescens*, *Persoonia falcata*, *Bursaria spinosa* subsp. *spinosa*, *Allocasuarina inophloia*, *Petalostigma pubescens* and *Grevillea glauca*. A sparse to dense lower shrub layer may include *Jacksonia thesioides*, *Acacia calyculata*, *Xanthorrhoea johnsonii* and *Grevillea glossadenia*. The ground layer may be dominated by species such as *Themeda triandra*, *Heteropogon triticeus*, *Mnesithea rottboellioides*, *Arundinella setosa*, *Cleistochloa subjuncea*, *Eriachne pallescens* var. *pallescens*, *Lepidosperma laterale* and *Xanthorrhoea johnsonii*. Rocky slopes on granite and rhyolite. (BVG1M: 9d).	LC	NCP	133.42
7.12.34	*Eucalyptus portuensis* (white mahogany) and/or *E. drepanophylla* (ironbark), +/- *C. intermedia* (pink bloodwood), +/- *C. citriodora* (lemon-scented gum), +/- *E. granitica* (granite ironbark) open woodland to open forest. Uplands on granite, of the dry rainfall zone. (BVG1M: 9d).	LC	NCP	23.76

RE	RE Description	VMA[1]	Bio.[2]	Area[3]
7.12.57a	Shrubland and low woodland mosaic with *Syncarpia glomulifera* (turpentine), *Corymbia abergiana* (range bloodwood), *Eucalyptus portuensis* (white mahogany), *Allocasuarina littoralis* (black sheoak) and *Xanthorrhoea johnsonii* (grasstree). Uplands and highlands on granite and rhyolite, of the moist and dry rainfall zones. (BVG1M: 9d). Vegetation communities in this regional ecosystem include: 7.12.57a: Shrubland and low woodland mosaic with *Syncarpia glomulifera*, *Corymbia abergiana*, *Eucalyptus portuensis*, *Allocasuarina littoralis* and *Xanthorrhoea johnsonii*. Uplands and highlands on granite and rhyolite, of the moist and dry rainfall zones. (BVG1M: 9d).	OC	OC	58.60
7.12.57c	Shrubland/low woodland (1.5-9 m tall) mosaic with variable dominance, often including *Eucalyptus cloeziana*, *Corymbia abergiana*, *E. portuensis*, *E. reducta*, *E. lockyeri*, *C. leichhardtii*, *Callitris intratropica*, *E. atrata*, *E. pachycalyx*, *E. shirleyi*, *E. drepanophylla* and *Homoranthus porteri*, on rhyolite and granite. There is occasionally a very sparse to sparse secondary tree layer of *C. abergiana* and/or *C. stockeri*. A very sparse to sparse tall shrub layer may be present and can include *Persoonia falcata*, *Exocarpos cupressiformis* and *Melaleuca viridiflora* var. *viridiflora*. A sparse to dense lower shrub layer may include *Jacksonia thesioides*, *Acacia calyculata*, *Coelospermum reticulatum*, *Xanthorrhoea johnsonii*, *Acacia humifusa*, *Dodonaea lanceolata* var. *subsessilifolia*, *Grevillea dryandri* subsp. *dryandri*, *Grevillea glossadenia*, *Acacia umbellata* and Ericaceae spp. The ground layer may be dominated by species such as *Themeda triandra*, *Xanthorrhoea johnsonii*, *Eriachne pallescens* var. *pallescens*, *Cleistochloa subjuncea*, *Borya septentrionalis*, and *Eriachne* spp. Includes open rocky dominated by herbs and grasses. This RE includes areas of 7.12.65k (rocky areas with shrubby/herbaceous cover) which are too small to map. Rocky slopes on granite and rhyolite. (BVG1M: 9d).	OC	OC	107.32

RE	RE Description	VMA[1]	Bio.[2]	Area[3]
7.12.58	*Eucalyptus reducta* woodland to open forest (6-18 m tall). Common associated species include *E. granitica*, *Corymbia dimorpha*, *C. citriodora*, *E. cloeziana* and occasionally *C. intermedia*. There is often a sparse secondary tree layer of *C. abergiana* and/or *E. lockyeri*. There may be a very sparse tall shrub layer of species such as *Acacia flavescens*, *Persoonia falcata*, *Allocasuarina littoralis* and *Acacia simsii*, and a very sparse to dense lower shrub layer of *Acacia calyculata*, *Pultenaea millarii*, *Jacksonia thesioides*, *Grevillea glossadenia*, *Grevillea dryandri* subsp. *dryandri*, *Homoranthus porteri* and *Dodonaea lanceolata* var. *subsessilifolia*. The ground layer is often dominated by species such as *Themeda triandra*, *Eriachne* spp., *Cleistochloa subjuncea*, *Lomandra longifolia*, *Mnesithea rottboellioides*, *Xanthorrhoea johnsonii*, *Heteropogon triticeus* and *Coronidium newcastlianum*. Granite and rhyolite. (BVG1M: 9d).	OC	OC	72.45
7.12.65k	Granite and rhyolite rock outcrop, of dry western areas, associated with shrublands to closed forests of *Acacia* spp. and/or *Lophostemon* spp. and/or *Allocasuarina* spp. In the Mount Emerald area, shrubs may include *Acacia umbellata*, *Melaleuca borealis*, *Homoranthus porteri*, *Leptospermum neglectum*, *Melaleuca recurva*, *Melaleuca uxorum*, *Grevillea glossadenia*, *Corymbia abergiana*, *Eucalyptus lockyeri*, *Sannantha angusta*, *Pseudanthus ligulatus* subsp. *ligulatus*, *Acacia aulacocarpa*, *Leptospermum amboinense*, *Xanthorrhoea johnsonii* and *Jacksonia thesioides*. Ground-cover species may include *Borya septentrionalis*, *Lepidosperma laterale*, *Eriachne* spp., *Cleistochloa subjuncea*, *Boronia occidentalis*, *Cheilanthes* spp., *Coronidium newcastlianum*, *Schizachyrium* spp., *Tripogon loliiformis*, *Gonocarpus acanthocarpus* and *Eragrostis* spp. Dry western areas. Granite and rhyolite. (BVG1M: 29b).	LC	OC	7.03

RE	RE Description	VMA[1]	Bio.[2]	Area[3]
9.5.8	Woodland to open-woodland of *Eucalyptus cullenii* (Cullen's ironbark) and/or *E. leptophleba* (Molloy red box) +/- *Corymbia erythrophloia* (red bloodwood) +/- *Erythrophleum chlorostachys* (Cooktown ironwood). *Eucalyptus tardecidens* (box) may also occur as a subdominant in northern extent of this regional ecosystem. A sparse shrub layer includes *Petalostigma* spp., *Melaleuca* spp., *Grevillea* spp., *Alphitonia pomaderroides* and *Maytenus cunninghamii* (yellowberry bush). The sparse to dense ground layer is dominated by *Heteropogon contortus* (black speargrass) and *Sarga plumosum* (plume sorghum). Occurs on undulating plains in valleys in ranges on Tertiary/Quaternary soils overlying granite and metamorphic geologies. (BVG1M: 13a)	LC	NCP	0.01
9.5.9a	Woodland to open-woodland of *Corymbia clarksoniana* (Clarkson's bloodwood) +/- *Eucalyptus platyphylla* (poplar gum) +/- *E. leptophleba* (Molloy red box) +/- *C. tessellaris* (Moreton Bay ash) with a distinct to sparse sub-canopy layer often including *Melaleuca viridiflora* (broad-leaved paperbark), *Grevillea glauca* (bushman's clothes peg), *Petalostigma pubescens* (quinine) and *Alphitonia pomaderroides* (soapbush). An open to sparse shrub layer includes *Melaleuca* spp., *Persoonia falcata*, *Grevillea* spp. and *Petalostigma pubescens* (quinine). The sparse to mid-dense ground layer is dominated by *Themeda triandra* (kangaroo grass), *Aristida* spp., *Heteropogon contortus* (black speargrass), *H. triticeus* (giant speargrass), and *Sarga plumosum* (plume sorghum). Occurs on undulating plains. (BVG1M: 9e).	LC	NCP	
9.12.7a	Woodland to open-woodland of *Eucalyptus cullenii* (Cullen's ironbark) +/- *Corymbia erythrophloia* (red bloodwood) +/- *Erythrophleum chlorostachys* (Cooktown ironwood) +/- *C. dallachiana* (Dallachy's gum). An open to mid-dense subcanopy can occur and includes a variety of species. The shrub layer is absent to open and dominated by *Maytenus cunninghamii* (yellowberry bush), *Alphitonia pomaderroides* (soapbush), *Petalostigma* spp., and *Acacia* spp. The ground layer is sparse to dense and dominated by *Heteropogon contortus* (black speargrass), *H. triticeus* (giant speargrass), *Themeda triandra* (kangaroo grass) and *Sarga plumosum* (plume sorghum) with a *Xanthorrhoea* sp. (grasstree) occurring in some areas. Occurs on rhyolite hills. (BVG1M: 13a).	LC	NCP	0.01

RE	RE Description	VMA[1]	Bio.[2]	Area[3]
9.12.40	Low open-woodland to low woodland of *Melaleuca citrolens* (scrub teatree) +/- *Terminalia platyptera* (yellow-wood) +/- *Corymbia dallachiana* (Dallachy's gum) +/- *Erythrophleum chlorostachys* (Cooktown ironwood). The sparse shrub layer consists of *Petalostigma banksii* (smooth-leaved quinine), *M. citrolens* and *Gardenia vilhelmii* (breadfruit). The ground layer is frequently bare, with patches of short grasses including *Eriachne* spp., *Aristida* spp. and *Schizachyrium* spp. (firegrass). This community also occurs as short open-tussock grassland wooded with low trees and shrubs of *Melaleuca citrolens* +/- *Terminalia* spp. Occurs on gentle slopes, footslopes, rolling hills and colluvial low slopes. (BVG1M: 21b).	LC	NCP	
Non-rem	Non-remnant: modified land, roads, clearings and tracks.			0.08

[1] Status under Vegetation Management Act 1999: OC - Of Concern; LC - Least Concern.

[2] Biodiversity management status: E - Endangered; OC - Of Concern, NCP - No Concern at Present.

[3] Area - total area in hectares of RE type within offset site.

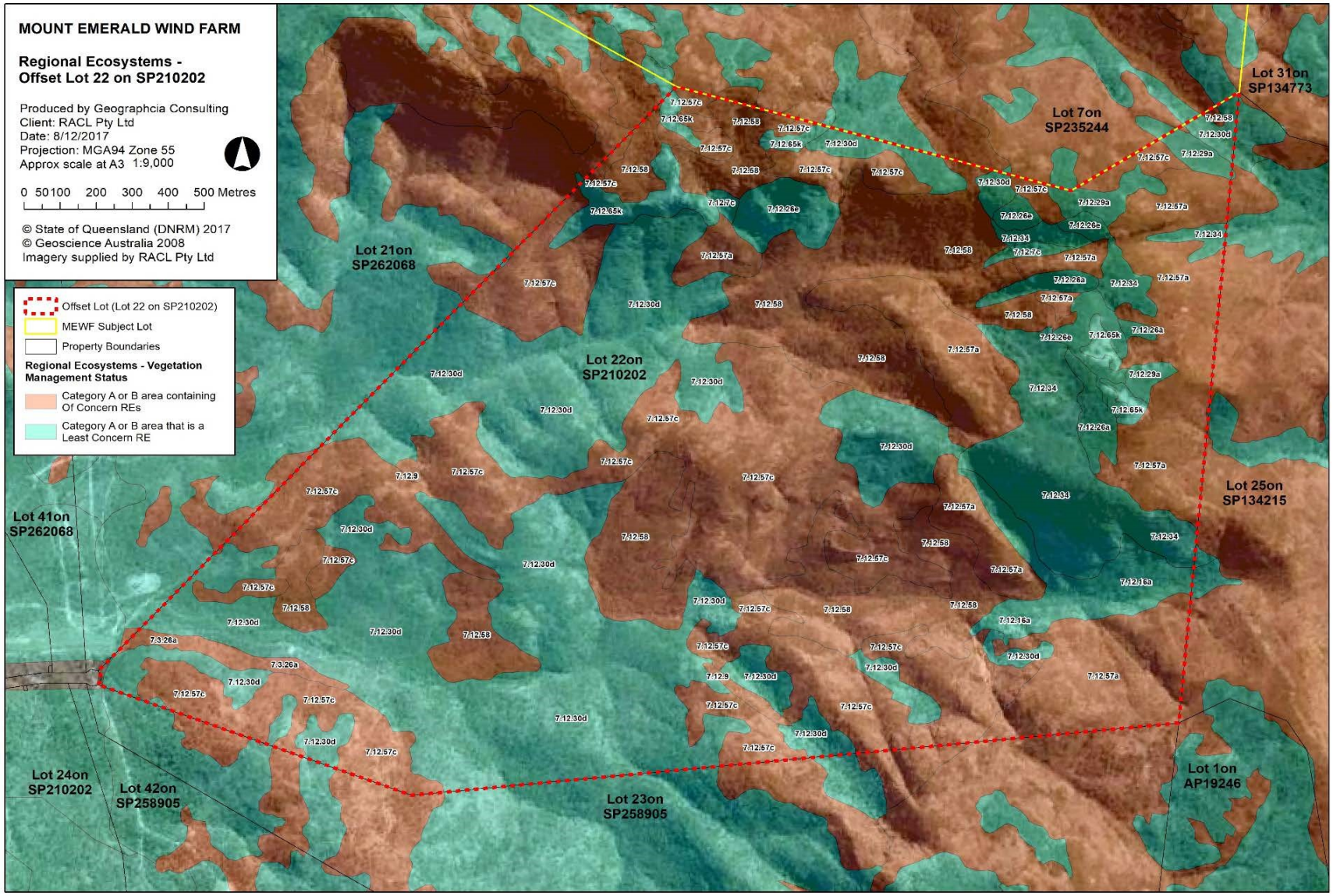

Figure 2 MEWF Offset Site Regional Ecosystems

2.0 Methods

The following sections detail the methods employed for the 2021 ecological offset area monitoring program. The methods employed as part of this monitoring program are consistent with those outlined in the MEWF Offset Area Management Plan (RPS 2016).

Field surveys were conducted on site over 5 days, from the 11-12 February and 1-3 March, 2021.

Total rainfall during the month of February was 235 mm. Mean minimum and maximum temperatures were 20.6 °C and 29.2°C respectively (BOM 2021).

2.1 Targeted Fauna Surveys for Conservation Significant Fauna

2.1.1 Northern Quoll (*Dasyurus hallucatus*)

Camera Trapping

The most suitable method for determining the presence of Northern Quoll is by undertaking a camera trapping survey. This method follows that of Eyre et al. (2014). This current survey has continued to annually replicate the original methodology, including camera deployment locations, of those of the 2016 surveys conducted by RPS (2016) shown in **Figure 3**.

A total of 19 camera traps (Bolyguard SG562-C) were used for the camera trapping survey, from the 11th of February to the 2nd of March, 2021. At each survey site a single camera trap was attached horizontally to the trunk of a tree with a 'dbh' (diameter at breast height) of at least 15 cm. Camera traps were attached using a metal 90° angle bracket, at ~1.5 metres above the ground facing directly over a single PVC bait cannister. Cannisters were made from 50 mm wide PVC piping capped at one end and partially exposed at the other with a vented cowling. Cannisters were baited with 3 chicken neck portions and fixed to the ground using a tent peg.

Each camera was set at the medium-level trigger sensitivity. All loose vegetation (e.g. grass stalks, forbs and shrub branches) within the field of view of each camera were removed to minimize false triggers. Individual Northern Quolls were identified by visually assessing the unique spot patterns on the quolls back. Population metrics for the Northern Quoll were analysed using the Minimum Number Known to be Alive (MNKA) method, in which the total number of individual animals captured is used as the population metric.

Field surveys were conducted on site over 5 days, from the 11-12 February and 1-3 March, 2021.

Habitat Assessments

Habitat assessments were conducted at each site.

Measurements of habitat will also be made. Parameters monitored:

- Evidence of fire;
- Nature and extent of erosion;

- Extent of weed species;
- Presence of feral animals;
- Type of groundcover;
- Structure and floristics of vegetation cover; and
- Number of habitat trees.

2.1.2 Spectacled Flying-fox (*Pteropus conspicillatus*)

Diurnal searches for roosts and feeding signs were undertaken over a large proportion of the project site per Eyre et al. (2014). Surveys followed meandering transects while traversing the offset site during set up of the systematic camera trapping survey. A survey for the presence of flowering forage trees was undertaken by an ecologist.

Previously survey efforts RPS (2016) and 4 Elements Consulting (2017, 2019, 2020) included nocturnal spotlighting. The current survey protocol did not include nocturnal spotlighting on ridge lines as it was determined to be unsafe due to the rugged terrain. The current survey effort recorded the availability of forage trees as an indicator of habitat suitability for the Spectacled Flying-fox

2.1.3 Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus nudicluniatus*)

To investigate the presence of Bare-rumped Sheathtail Bat and the overall diversity of microbats on the offset site a microbat call analysis was undertaken. This was conducted by audio recording microbat echolocation call pulses using acoustic bat detection (Song Meter) devices. Acoustic devices, Song Meter SM4 BAT recording detectors, were deployed at six locations on the offset site (**Figure 3**). Each detector was placed within a suitable flyway (typically a passage of less dense vegetation) and in areas sheltered from strong prevailing winds. Each detector was fastened to the trunk of a tree and an SMM-U1 Ultrasonic Microphone was attached to each unit via an extension cable. The detectors were programmed to turn on automatically at 6 pm each evening and record for a 12-hour period. Call analysis was conducted by a 4 Elements Consulting ecologist. Species were identified by examining the shape and frequencies of the call pulses against known bat call pulses. Unknown calls were further examined by using published call keys in Reinhold (2001) and Milne (2002). Finally, all calls were then verified by Greg Ford (Balance! Environmental). Greg Ford is a recognised microbat call expert in the industry.

Song Meters were deployed from the 1-14 March and 2-15 June. The second deployment occurred to increase the data set due to the lack of BRSB calls in the previous survey and prior year and ensure that there was sufficient spatial and temporal data collection.

2.2 Targeted Weed Surveys

A weed assessment was undertaken within the MEWF Offset site which concentrated on the access track from Lemon Tree Drive and the Mount Emerald Walking Track that leads to the summit of Mount Emerald. The entire

length of these tracks was traversed on foot by a field botanist. Additional spot observations of weed presence in remnant, undisturbed vegetation was undertaken previously in 2016, 2017, 2019 and during the current survey effort.

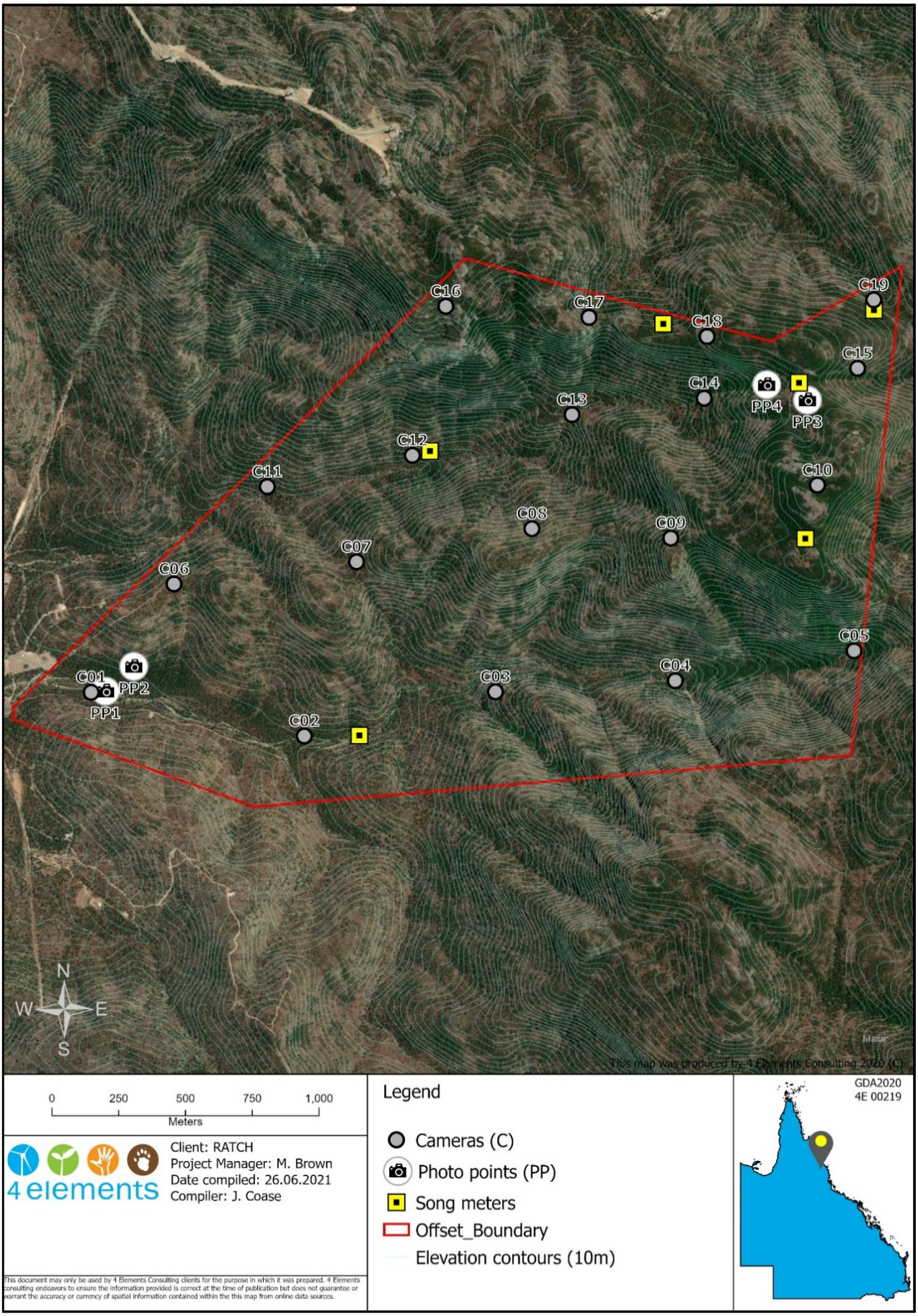

Figure 3 Monitoring Points on Offset Lot

2.3 Opportunistic Assessment

Opportunistic assessments of fauna were monitored at 19 sites. The parameters monitored were:

- Diurnal bird;
- Herpetofauna;
- Terrestrial mammal; and
- Threatened species presence.

2.4 Photo-Monitoring Points

Four photo monitoring points were established in 2016 within the offset area to enable a visual assessment of changes over time within distinct vegetation types (**Figure 3**). Each point was:

- Marked with a 1 m star picket which was flagged with yellow tape and the GPS points recorded;
- Each point had photographs taken in all cardinal directions; and
- Metadata which included GPS co-ordinates, data and time were recorded.
- Photographic and metadata records are taken at these photo monitoring points annually.

2.5 Vertebrate Pest Assessment

2.5.1 Camera Trap Locations

Secondary monitoring data was achieved from the deployed camera traps (refer to **Section 2.1**). Pigs, feral dogs and cats are all known to be attracted to the chicken neck bait used.

Data collection included:

- Species identification (feral pigs and other animals);
- Number of each species;
- Age class of feral pigs; and
- Sex of feral pigs.

3.0 Results

3.1.1 Fire Impacts on the MEWF Offset Site

A high intensity fire moved through parts of the MEWF Offset site in late September 2020 with three (3) of the four (4) photo monitoring points burning during the fire event (see **Figure 3** and Section 4.1 **Table 4**). The only photo monitoring point that did not burn was point 4 which is located in a deep boulder lined gully supporting dry rainforest vegetation. All other monitoring sites are within sclerophyll open woodland communities. All very high intensity canopy fires were recorded on the eastern boundary (**Plate 1**). At the time of survey, these areas were in recovery with nearly all canopy trees displaying epicormic budding. As a result of this fire event, no canopy tree flowering was observed in these areas (near to photo monitoring point 3). The same fire has travelled through to the western boundary of the property to impact a high proportion of the western slopes. At this section of the property visual assessment appeared to indicate a less intense fire. Although, much of the understory was burned in this section.

Plate 1 North East Facing Boundary Displaying Epicormic Sprouting in Regenerating Canopy

3.1.2 Northern Quoll Monitoring

A total of 333 camera trap nights were conducted on the offset site and all units captured images. Northern Quolls were detected at 11 of the 19 camera trap stations on the offset site. Trap histories over the survey period and corresponding camera trap locations showing where quolls were captured on the offset site are detailed in **Table 2** below. In total, seventeen (17) individual Northern Quolls were recorded during the camera trapping survey and many of the quolls revisited the same site on multiple nights (**Plate 2**). This total is an increase from 16 individuals in the previous survey conducted by 4 Elements Consulting (2019) and from the 2016 baseline surveys of 13 individuals RPS (2016). Two (2) Northern Quolls were located at multiple monitoring locations, identified from the unique spot marking on their backs.

Site 7 recorded the five (5) individual Northern Quolls which was the highest abundance of any other site. Site 6 had the next highest abundance which recorded three (3) individual quolls. Northern quolls were detected at all of the 19 camera trap locations on the offset site.

Plate 2 Northern Quoll at Camera Site 6

Table 2 Quoll Capture histories over the survey period. 17 individual Northern Quolls were captured at 11 camera trap sites.

SITE	QUOLL ID	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13	Day 14	Day 15	Day 16	Day 17	Day 18	Day 19	Day 20	Day 21
1	QO1							1					1							1		
1	QO2																	1				
4	QO3		1																1			
6	QO4		1	1		1		1						1								
6	QO5					1		1					1									
6	QO6							1														
7	QO7				1				1													
7	QO8						1															
7	QO9								1												1	
7	Q10									1			1	1								
7	Q06																	1				
8	Q11									1												
9	Q12								1				1									
11	Q13				1	1									1							
13	Q14					1																
14	Q15									1												
17	Q16	1																				
19	Q15								1													
19	Q17																	1				

3.1.3 Spectacled Flying-fox

Targeted diurnal searches for the Spectacled Flying-fox (SFF) habitat concentrated in areas where vegetation was either in fruit or flower. As with the previous year, this corresponded to the gully lines which support complex dry rainforest communities. These were considered important as they were some of the only areas not impacted by fire. At the time of the survey, these areas contained fruiting Burdekin Plum (*Pleigynium timorense*) which may have provided some foraging potential for Spectacled Flying-fox. Very few flowering eucalypt trees were observed on the site due to the fire event of September 2020. No Spectacled Flying-foxes were observed in the current survey effort.

3.1.4 Microbat Analysis

A total of 77 detector nights, for microbat call surveys, were conducted within the project site between the 11th of February and the 16th of June 2021.

A total of eleven microbat species were detected as a definite occurrence within the study site. Two microbat species were identified as probable and four as a possible occurrence on the site (**Table 3**).

The call data was analysed for the presence of Bare-rumped Sheathtail Bat (BRSB), listed as *Endangered* under NC Act, and listed as *Vulnerable* under EPBC Act. No Bare-rumped Sheathtail Bats were recorded in the current survey data. Whilst some calls collected appear to be superficially like that of the Bare-rumped Sheathtail Bat, call analysis–revealed these calls were from other species within the Emballonuridae family (*Saccolaimus flaviventris* and *Taphozous troughtoni*) and Molossidea family (*Chaerophon jobensis*). None of these species are listed threatened species under state or federal legislation.

Table 3 below provides a detailed summary of the bat call analysis undertaken by Greg Ford.

Table 3 Summary of Call Analysis

Species	Status EPBC	Status NCA	Confidence of Presence
Austronomous australis	-	Least Concern	Definite
Chaerophon jobensis	-	Least Concern	Definite
Saccolaimus flaviventris	-	Least Concern	Definite
Chalinolobus gouldii	-	Least Concern	Definite
Ozimops ridei	-	Least Concern	Definite
Taphozous troughtoni	-	Least Concern	Definite
Miniopterus australis	-	Least Concern	Definite
Vespadelus pumulis	-	Least Concern	Definite

Species	Status EPBC	Status NCA	Confidence of Presence
Rhinolophus megaphyllus	-	Least Concern	Definite
Ozimops lumsdenea	-	Least Concern	Definite
Chalinolobus nigrogriseus	-	Least Concern	Possible
Miniopterus oceanensis	-	Least Concern	Definite
Scrotoropens orion	-	Least Concern	Possible
Scrotoropens sanborni	-	Least Concern	Possible
Vespedalus troughtoni	-	Least Concern	Probable
Pipistrellus adamsi	-	Least Concern	Possible
Scrotoropens greyii	-	Least Concern	Probable

3.2 General Fauna Observations

From a combination of camera trap and opportunistic sightings during site traverses, a total of 44 species were able to be positively identified, except for the rodents, which could not be identified to the species level from camera trap images. In total, 21 birds and 24 mammals were positively identified.

The birds included species such as the Pheasant Coucal (*Centropus phasianinus*), Noisy Friarbird (*Philemon corniculatus*), Striated pardalote (*Pardalotus striatus*) and Tawny frogmouth (*Podargus strigoides*).

The cryptic Mareeba Rock-wallaby (*Petrogale mareeba*) was identified on the mid mountain slopes at site 14. The Echidna, *Tachyglossus aculeatus,* was sighted in multiple locations across the site as evidenced by scats.

A complete list of fauna species is provided in **Appendix A**.

3.3 Weed Monitoring & Control

Since it was first recorded in a weed survey conducted in January 2018, a population of Grader Grass (*Themeda quadrivalvis*) has established a seed bank along the main access track from Lemontree Drive. This species is readily detectable, had not been previously recorded on site prior to this January 2018 survey. In 2018, Grader Grass extended from the access track entry gate to the vehicle turnaround at the end of the track. The extent was similar in 2020, with the population distributed along the length of the access track with most individuals occurring at the vehicle turnaround (**Plate 3**). In 2020, the Grader Grass infestation was hand-pulled twice per wet season and placed into garbage bags and removed from site. This control method was continued in 2021 with a noticeable reduction in the size of the infestation at this location.

The Mount Emerald walking track, which provides pedestrian access to the summit of Mount Emerald, is another source of weeds for the study site. Close to the walking track, a number of weed populations have been recorded. These include Molasses Grass (*Melinis minutiflora*) which occurs in exposed situations at high elevations (**Plate 4)** and occasionally in rocky gullies. This species is potentially problematic and will be monitored to determine if it is likely to spread further and present a threat to high elevation rock pavement communities on the offset site. At this stage the site population of this species, as shown in **Plate 4**, is restricted and has no vehicular access to support herbicide application. The rock pavement communities have shallow soil lenses which may be eroded during the wet season if the current stabilisng *Melinis* population is killed/removed. If the population is not invading the site further no action is recommended except to monitor the population for spread.

Three (3) discrete Grader Grass incursions have been recorded near the summit of Mount Emerald since 2018. These have been actively managed by hand pulling and covering in thick black builder's plastic as a method of killing the plants (solarisation). This control method has continued in the current weed treatment. No expansion of these three (3) populations has been recorded. Results of the treatment are shown in **Plate 5**.

Plate 3 Lemontree Drive Turnaround Grader Grass Incursion Post Treatment (-17.21175, 145.39055)

Plate 4 ***Melinis minutiflora*** **Growing Near to Of Concern RE 7.12.65k (-17.20127, 145.40718)**

Plate 5 **Grader Grass Incursion Post Treatment (-17.19771, 145.40668)**

4.0 Pest Vertebrate Monitoring

Two (2) individual feral cats were seen on the camera trapping images (see **Plate 6** and **Plate 7**) at site 6 and 19. Feral cats occur commonly across the region and have been recorded on the MEWF Offset Site and MEWF Project Site during previous targeted camera trapping events.

Plate 6 Feral cat identified at camera site 6

Plate 7 Feral cat site 19

4.1 Photo Monitoring Points

A visual assessment was undertaken at four photo monitoring points. These locations were selected based on habitat quality, Regional Ecosystem attributes and location. **Table 4** below summarises the characteristics of these sites where photographs are orientated towards the North, South, East and West facing directions. Whilst the photo will aid in the broad comparisons over time, they are best used in combination with floristic data (Gleed 2017) as they are unlikely to show fine scale changes on their own.

Table 4 Photo Monitoring Points

Site ID	Description	Photograph from North, South, East, West	
Photo Point 1 Location: UTM 55K 0327999, 8096486	Mapped as RE 7.3.26a Site only partially conforms to mapped RE absence of *Allocasuarina cunninghammii.* Alluvial sandy loam on riverine wetland. Canopy of *Eucalyptus tereticornis*, *Corymbia leichardtii* with a sparse shrub layer containing *Lophostemon grandiflorus*, *Bursaria tenuifolia*, *Exocarpus cupressiformis, Callitris intratropica, Acacia spp.* with a ground layer containing *Heteropogon triticeus*, *Sarga spp.* and *Themeda triandra*.	 **North**	 **South**
		 **East**	 **West**

Site ID	Description	Photograph from North, South, East, West	
Photo Point 2 Location: UTM 55K 0328099, 8096579	Mapped 7.12.30d Site conforms to RE containing dominant canopy and shrub and ground layer associates. Rocky slopes on granite and rhyolite. Canopy *Eucalyptus cloeziana*, *Corymbia leichardtii* and *Eucalyptus crebra* with a very sparse shrub layer containing *Petalostigma pubescens*, *Coelospermum reticulatum, Persoonia falcata, Grevillea parrallela* and a ground layer containing *Heteropogon triticeus*, *Sarga spp.* and *Themeda triandra*.	 **North**	 **South**
		 **East**	 **West**

Site ID	Description	Photograph from North, South, East, West	
Photo Point 3 Location: UTM 55K 0330501, 8097591	Site conforms to RE 7.12.57a containing low open woodland to shrubland containing key canopy and lower level associates. High uplands slopes on granite and rhyolite. Tall shrub/ low tree layer *Syncarpia glomulifera, Corymbia abergiana, Eucalyptus portuensis, Eucalyptus crebra, Allocasuarina littoralis. Banksia aquilonia.* Ground layer *Xanthorrea johnsoni, Themeda triandra, Imperata cylindrica, Pteridium esculentum,*	 **North**	 **South**
		 **East**	 **West**

Site ID	Description	Photograph from North, South, East, West	
Photo Point 4 Location: UTM 55K 0330355, 8097647	Mapped as RE 7.12.16a Site conforms to mapped RE containing simple to complex notophyll vine forest with emergent *Agathis microstachya* on granite and rhyolite in the uplands of the moist rainfall zone. *Agathis microstachya* emergent layer absent. All other vegetation layers conform to RE 7.12.16a.	 **North**	 **South**
		 **East**	 **West**

5.0 Discussion

5.1 Threatened fauna

Results from the current survey effort reveal the Northern Quoll population has remained generally stable since surveys began in 2016. Small population fluctuations have occurred, although this can be attributed to seasonal variations within a population across the survey periods, as seasonality is known to affect quoll populations (i.e., greater numbers within the winter periods). Overall, the offset site has maintained its ecological integrity and the habitat observed remains as high-quality habitat with large refugial areas of rock outcrops, tree hollows and fallen logs for the Northern Quoll. The ephemeral creeks from the Mt Emerald Offset Site had good flow due to the good wet season conditions at the time of survey, with freshwater crustaceans, fish and an abundance of insects observed across the site.

No Spectacled Flying-foxes were detected during the current survey effort. During this time, none of the potential forage trees were observed to be in fruit or flower and the lack of sightings probably reflects the absence of a food source at the time of survey. Despite lack of sightings, the offset site is still deemed to be adequate for the Spectacled Flying-fox and detections of this species may be recorded during different survey seasons and periods (nocturnal spotlighting surveys).

No Bare-rumped Sheathtail Bats were recorded during the current survey, despite a greater survey effort. Previous audio surveys have recorded this species as a probable occurrence on the offset site, however, the call pulses of this bat are superficially similar to other common bat species, which may lead to difficulties in identification. Furthermore, there is the potential that a population of Bare-rumped Sheathtail Bats may have previously resided on the offset site and have since moved on to other areas, either from natural movements or forced migration due to environmental stressors (i.e., intense fires). Very little information on the population dynamics of this species exists across its range, thus the extent of the population of this species in the region remains unknown. Whilst this is the case, the offset site displays ecological habitat characteristics that would be beneficial for the Bare-rumped Sheathtail Bat. Further surveys across a greater area of the offset site are recommended to determine the species presence on the offset site and potential expansion of the monitoring program to include the Mount Emerald Project Site may be useful in determining the presence of this species in the region.

5.2 Biodiversity Management Issues

5.2.1 Weeds

The most prominent biodiversity management issue for the offset site is the control of invasive weeds. Whilst several weed species occur across the offset site, a major weed of concern is Grader Grass (*Themeda quadrivalvis*). Incursion of this invasive grass has occurred along areas of the access track off Lemontree Drive, as well as three (3) small patches on the northern slopes of the offset site. These populations have been effectively managed in

the current weed treatment; however, ongoing monitoring and management will be required at the commencement of the next wet season to prevent populations from re-establishing. Other weeds, such *as Mesosphaerum suaveolens* (syn: *Hyptis suaveolens*) have been recorded on the access track and will require further control and monitoring prior to the next wet season. No expansion of weeds has been recorded in the last four (4) years of monitoring. This would indicate that although eradication of these weeds has not been achieved, management to prevent spread has been effective. With continued management it is expected that the weed seed bank will be further reduced in subsequent years.

5.2.2 Pest Species

The biodiversity offset area is considered to contain a low density of pest fauna species, with only two (2) feral cats being observed in the current survey effort.

No feral pigs were observed during the current survey round. Typically, the offset site provides high quality foraging habitat for feral pigs within the dry season as moisture is retained on the offset site due to the south-easterly aspect of the highest elevation area producing a cloud stripping effect. This allows for moisture to be retained for longer periods than elsewhere on the MEWF project site. However, the lack of feral pig sightings during the current survey suggests that the feral pig population is dispersed across the local region as foraging conditions are ideal during the current survey period (late wet season).

Camera traps should be selectively used to record feral pig activity across the site. This will give an indication of the proportion of pigs which are impacting the habitat. The employment of bait stations will assist in obtaining more accurate records of feral pig visitation rates.

5.2.3 Timing

It is recommended further monitoring surveys be conducted in April– July 2023, close to the end of the wet season, to encompass full flowering of plants to ensure feeds trees are available and fauna are most mobile throughout their range.

6.0 Summary

This report presents results of the fourth biennial fauna survey for the Mount Emerald Windfarm Offset Site. One threatened fauna species, the Northern Quoll (*Dasyurus hallucatus*), was confirmed on the offset site. Population estimates using the Minimum Number Known to be Alive (MNKA) method have revealed that quoll population estimates have not changed significantly since surveys began.

Fauna habitat resources remain abundant within the MEWF Offset Site, and the habitat is of high quality. The offset site has a high density of the large hollows that several nocturnal birds of prey, bat and small to medium sized mammal species require for breeding. In addition, small mammals (terrestrial and arboreal), which are the respective prey of a number of predatory species, were identified throughout the site. Canopy tree species and understorey shrubs within the site provide abundant foraging resources such as foliage, seeds, pollen, nectar and invertebrates for variety of species on a seasonal basis and may potentially influence the occurrence and abundance of arboreal mammal species and birds.

The ground cover layer has remained relatively consistent on the site since surveys began in 2016, despite the recent fire which occurred in October 2020. Recent good rains have promoted a dense ground layer across the site. Suitable amounts of coarse woody debris remain across the site, which provides excellent habitat for small mammals and reptiles.

Weed surveys indicate there are currently no priority listed weed species on site, however, vigilance will be required along the walking track and road entry to ensure there are no access points for these threats. Continued management measures to remove weeds from tracks and external site boundaries will reduce the risks significantly.

The ecological condition of the MEWF Offset Site has been maintained since baselines surveys were conducted in 2016.

7.0 References

4 Elements Consulting (2017) Mount Emerald Offset Area Monitoring Program Report. Prepared for RATCH Australia Corporation, Brisbane.

4 Elements Consulting (2018) Mount Emerald Offset Area Monitoring Program Report. Prepared for RATCH Australia Corporation, Brisbane.

4 Elements Consulting (2019) Mount Emerald Offset Area Monitoring Program Report. Prepared for RATCH Australia Corporation, Brisbane.

Burnett S, Shimizu Y and Middleton J (2013) Distribution and abundance of the northern quoll (*Dasyurus hallucatus*) in far north Queensland. Unpublished report to Ratch Australia.

Bureau of Meteorology (2021) Walkamin, Qld - Daily Weather Observations (bom.gov.au), Brisbane

Eyre TJ, Ferguson DJ, Hourigan CL, Smith GC, Mathieson MT, Kelly, AL, Venz MF, Hogan, LD & Rowland, J (2014) Terrestrial Vertebrate Fauna Survey Assessment Guidelines for Queensland. Department of Science, Information Technology, Innovation and the Arts, Queensland Government, Brisbane.

Eyre T, Ferguson DJ, Hourigan CL, Smith GC, Mathieson MT, Kelly AL, Venz MF, Hogan LD A Rowland, J (2014) Terrestrial Vertebrate Fauna Survey Assessment Guidelines for Queensland. Department of Science, Information Technology, Innovation and the Arts, Queensland Government, Brisbane.

Gleed S (2016) Mt Emerald Threatened Species Management Plan. Prepared for RATCH Australia Corporation, Brisbane.

RPS Australia East (2016) Offset Area Management Plan. Unpublished Report prepared for RATCH Australia Corporation Limited, Brisbane.

Appendix A Fauna List

A summary of species identified during survey on the MEWF Offset Site.

Species	Common Name
Bird	
Alectura lathami	Australian Brush-turkey
Milvus migrans	Black Kite
Lichmera indistincta	Brown Honeyeater
Colluricincla harmonica	Grey Shrike Thrush
Dacelo novaeguineae	Laughing Kookaburra
Myiagra rubecula	Leaden Flycatcher
Meliphaga lewinii	Lewin's Honeyeater
Philemon corniculatus	Noisy Friarbird
Manorina melanocephala	Noisy Miner
Platycercus adscitus	Pale-headed Rosella
Centropus phasianinus	Pheasant Coucal
Strepera graculina	Pied Currawong
Merops ornatus	Rainbow Bee-eater
Malurus melanocephalus	Red-backed Fairywren
Neochmia temporalis	Red-browed Finch
Dicrurus bracteatu	Spangled Drongo
Smicrornis brevirostris	Weebil
Haliastur sphenurus	Whistling Kite
Melithreptus lunatus	White-naped Honeyeater
Pardalotus striatus	Striated Pardalote
Podargus strigoides	Tawny Frogmouth
Mammal	
Dasyurus hallucatus	Northern Quoll
Petrogale marreba	Mareeba Rock Wallaby
	Rodent sp.

Species	Common Name
Trichosurus vulpecula	Common Brushtail Possum
Tachyglossus aculeatus	Short-beaked Echidna
Felis catus	Feral Cat
Isoodon macrourus	Northern Brown Bandicoot
Wallabia bicolor	Swamp Wallaby
Austronomous australis	White-striped Free-tailed Bat
Chaerophon Jobensis	Northern Freetail Bat
Saccolaimus flaviventris	Yellow-bellied Sheath-tailed Bat
Chalinolobus gouldii	Gould's Wattled Bat
Ozimops ridei	Ride's Free-Tailed Bat
Taphozous troughtoni	Troughton's Sheath-tailed Bat
Miniopterus australis	Little Bent-wing Bat
Vespadelus pumulis	Eastern Forest Bat
Rhinolophus megaphyllus	Eastern Horseshoe Bat
Ozimops lumsdenea	-
Chalinolobus nigrogriseus	Hoary Wattled Bat
Miniopterus oceanensis	Eastern Bent-winged Bat
Scrotoropens orion	Eastern Broad-nosed Bat
Scrotoropens sanborni	-
Vespedalus troughtoni	Eastern Cave Bat
Pipistrellus adamsi	Forest Pipistrelle
Scrotoropens greyii	Little Broad-nosed Bat

D. BIOCONDITION VEGETATION ASSESSMENT

Bio-condition Vegetation Assessment

Mount Emerald Wind Farm Offset Site

April 2022

4 elements

Bio-condition Vegetation Assessment

Mount Emerald Wind Farm Offset Site

April 2022

Revision History

Version	Purpose	Issued by	Date	Reviewer	Date
0.01	Draft	Ryan Hughes	05-04-2022	Raelee Kerrigan	07-04-2022

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1.0 Introduction

Bio-condition assessments on the Mount Emerald Wind Farm (MEWF) Offset Site have been completed by 4 Elements Consulting on behalf of RATCH Australia Corporation Ltd (RATCH). This has been completed as part of the Mount Emerald Offset Management Plan monitoring requirements.

The purpose of these Bio-condition assessments is to provide detailed information on a range of vegetation communities that are present within the MEWF Offset site and repeat this effort biennially to monitor vegetation condition through time. It is important that the widest variety of regional ecosystems are captured in the baseline round of survey to detect any future changes to vegetation condition across the site. For this purpose, a total of 18 permanent sites have been located throughout the MEWF offset site. The first round of monitoring occurred over two consecutive years (2018/19) see (4 Elements, 2019). From this point forward it is expected that all 18 bio-condition plots will be monitored biennially in the same year. A summary of survey results for the latest survey period (April 2020) is provided in the below report body. Biennial surveys will continue until 2028 as per the Offsets Area Management Plan (RPS, 2016).

1.1 Site Threatened Flora

To offset impacts to threatened flora because of the construction of the Mount Emerald Wind Farm, a biodiversity offset (MEWF Offset site) was established and subsequently gazetted as a nature refuge in 2018 under the *Nature Conservation Act 1992*. A baseline survey was conducted over this property (Gleed, 2016) with one of the key aims being to determine the presence of threatened flora listed under the *Nature Conservation Act 1992* and the *EPBC Act 1999* on the MEWF offset site. A total of eight (8) listed species were recorded in this survey. With seven of these species being present on the Mount Emerald Wind Farm Project Site.

All listed threatened flora that was known to be present from the baseline survey has been recorded during the MEWF offset site in the current round of monitoring. Three (3) additional species have also now been included under a conservation listing since this the baseline survey which include *Zieria fordii, Comesperma anemosmaragdinum* and *Eleutheroglossum fellowsii*. This now brings the total number of threatened species present within the MEWF Offset Site to 11 species. All listed threatened species under the *EPBC Act* and or *NC Act* present on the MEWF offset site are listed below;

- *Acacia purpureopetala* (Purple-flowering Wattle) - Critically Endangered (EPBC Act), Vulnerable (NC Act);
- *Comesperma anemosmaragdinum* (no common name) – Endangered (NC Act);
- *Grevillea glossadenia* (no common name) - Vulnerable (EPBC Act), Vulnerable (NC Act);
- Eleutheroglossum fellowsii (Native Damsel Orchid) – Vulnerable (NC Act);
- *Homoranthus porteri* (no common name) - Vulnerable (EPBC Act), Vulnerable (NC Act);
- *Melaleuca sylvana* (no common name) – Endangered (NC Act);
- *Melaleuca uxorum* (no common name) - Endangered (NC Act);

- *Plectranthus amoenus* (Plectranthus) - Vulnerable (NC Act);
- *Prostanthera albohirta* (a mint bush) – Critically Endangered (EPBC Act), Critically Endangered (NC Act);
- *Prostanthera clotteniana* (Mint Bush) - Critically Endangered (EPBC Act), Endangered (NC Act);
- *Zieria fordii* (Ford's Stink-bush) – Critically Endangered (NC Act).

The bio-condition monitoring survey locations have been selected to include threatened flora populations so that the survey plots may act as a monitoring tool of the threatened flora population health on the site. Most species present on MEWF project site are represented within a bio-condition except for *Melaleuca sylvana*.

2.0 Methodology

The methodology of this year's Bio-condition sampling follows closely the work in the previous two (2) monitoring periods (4 Elements, 2019 and Four Elements 2020). The methods used for the Bio-condition assessments followed those described by Eyre et al. (2017) and Neldner et al. (2017). The method works on a series of plots and transects nested within a survey area of 10,000 m^2 (1 ha).

The location of the bio-condition sites provides the opportunity to monitor a subset of the threatened flora populations present on the offset site. All new records of threatened flora are recorded and collected for submission to the herbarium when traversing the offset site. All threatened flora species present within any bio-condition plots are recorded and tallied in the results summary tables for each site (see section 3 results). Any sign of dieback or disease are recorded along with any flowering, fruiting and juvenile plant recruitment is recorded to monitor population health and persistence through time. An opportunistic weed survey is also undertaken during site traverse.

2.1 Time of Survey

The survey period was conducted over multiple days between the dates of 17 February and the 10 April 2022. This timing is considered the optimal timing for flora assessment when prevailing warm wet conditions promote plant growth and reproduction. All ground forbs, herbs and grasses were readily detectable and could often be confidently identified to species. The exception was for a small number of grass species that could occasionally only be identified to the genus level. This did not impact on the species abundance tally for the bio-condition assessment.

2.2 Survey Limitations

Under the MEWF Offset Area Management Plan, (RPS, 2016), the schedule of two (2) replicates for each of the Offset properties Regional Ecosystems was determined to be a requirement under the MEWF approval with conditions (EPBC 2011/6228). Although this monitoring schedule uses the bio-condition conditional assessment (Eyre *et al* 2015) to assess vegetation condition, a bio-condition score is unable to be applied to the sampled vegetation communities. This is primarily due to the fact that there are currently no published reference sites for any vegetation communities within the Wet Tropics Bioregion to which the property is located entirely within. Therefore, a requirement to survey a minimum of three (3) external reference sites are required to be surveyed for each Regional Ecosystem that has been sampled within the offset property. This is outside the scope of this monitoring schedule as determined in the project approval conditions.

Every effort was made to provide two replicate sites for each of the discreet remnant vegetation communities and relevant sub-categories mapped under the Regional Ecosystem Description Database Version 11.1 (REDD 2019). Due to difficulty in accessing some regional ecosystems (RE's) associated with steep and loose rocky terrain, not all could be replicated twice. Both RE 712.57a and RE 7.12.26e were only sampled with a single

replicate due to difficulty in site access. Other regional ecosystems were rare on site occurring only at a single location and therefore, these RE's were also only sampled utilizing a single replicate. These included the vine forest and riverine communities of RE 7.12.9, RE 7.12.7c, RE 7.3.26a and RE 7.2.16a. These regional ecosystems are also not represented on the Mount Emerald Wind Farm site and therefore not considered as high a priority for monitoring. All other regional ecosystems have two (2) independent replicates for future monitoring. Summary of sampled vegetation communities are summarised in **Table 1**.

For some Regional Ecosystems (e.g. RE 7.12.65k and RE 7.12.57a) a 100 m transect within the plot was not possible due to the limited extent of the community on narrow rock outcrops or within narrow rocky gullies. A 50 m transect was used in these situations and data extrapolated to the 1 ha survey area. Where a 50m transect was utilised it is listed in (**Table 1**) below.

Table 1Bio-condition Sampling Frequency on the MEWF Offset Site

Regional Ecosystem (REDD)	Survey Number	No. of Replicates	Transect Length (m)
RE 7.12.65k	Site 2, Site 17	2	50
RE 7.12.58	Site 1, Site 18	2	100
RE 7.12.57a	Site 15	1	50
RE 7.12.57c	Site 3, Site 16	2	100
RE 7.12.34	Site 12, Site 13	1	100
RE 7.12.30d	Site 4, Site 8	2	100
RE 7.12.29a	Site 9, Site 14	2	50
RE 7.12.26e	Site 10	1	100
RE 7.12.16a	Site 6	1	25
RE 7.12.9	Site 5	1	25
RE 7.12.7c	Site 11	1	100
RE 7.3.26a	Site 7	1	100

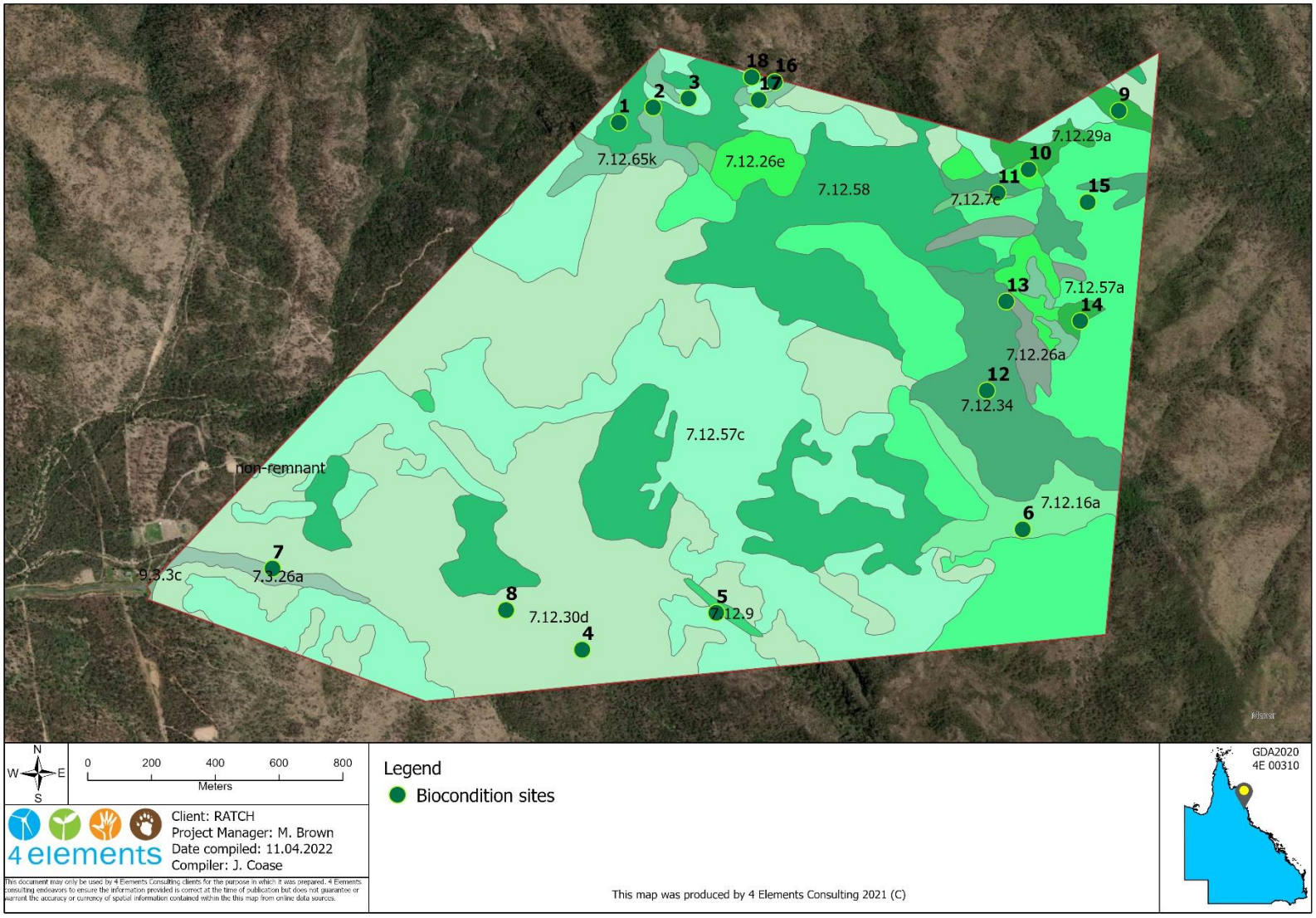


Figure 1 ***MEWF Offset Bio-condition Assessment Plot Locations***

3.0 Bio-condition Report Summary

3.1 Additional New Threatened Flora Records

In addition to monitoring the vegetation condition throughout the offset property, the bio-condition assessment has provided opportunity to monitor the distribution of threatened flora populations whilst moving between sites. All the eight (8) known threatened flora species known to be present in the initial 2016 survey were recorded in the current monitoring period. All species except for EPBC listed *Critically Endangered Prostanthera albohirta*, *Prostanthera clotteniana* and *Zieria fordii* the *Endangered Melaleuca sylvana* were recorded within individual bio-condition monitoring plots as indicated in **Appendix A**. The following section details all new records including basic habitat descriptions of threatened flora records of the latest survey period.

3.1.1 Acacia purpureopetala

The EPBC Act 1999 listed Critically Endangered and NC Act 1992 Vulnerable *Acacia purpureopetala* has been recorded at a single location within the offset site (see **Figure 2**). Since the previous survey (4Elements 2020) a further two (2) populations have been located approximately 250 m to the north and 600 m to the north (see **(Figure 2**). These two (2) additional populations were in a similar aspect and vegetation community as the original record (see **Plate 1 & Plate 2**). This included a SE facing slope within RE 7.12.30d at an elevation between 650 and 750 m asl. Both additional sites had been burnt in October 2020 with the previous record unimpacted by fire.

Plate 1 Location of additional Purple Acacia Record Post Fire (July 2021)

Plate 2 Unburned Fruiting Purple Acacia Within New Location Post Fire (July 2021)

Plate 3 Flowering *Acacia purpureopetala* at Bio-condition site 4 (February 2022)

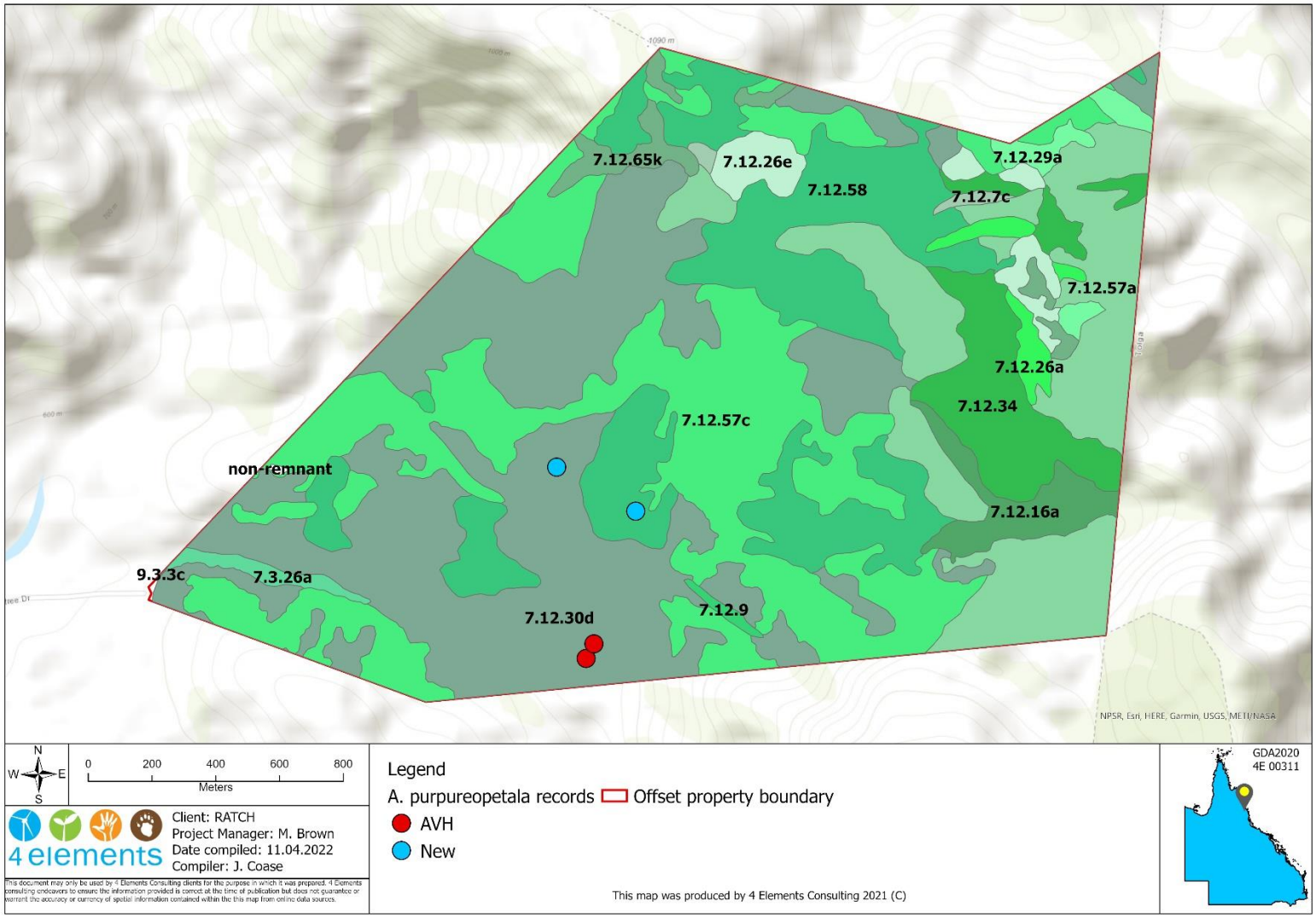


Figure 2 ***Acacia purpureopetala*** **Indicating Australian Virtual Herbarium (AVH) Records and New 2021 Records**

3.1.2 Eleutheroglossum fellowsii

During the most recent monitoring period, a new population of the *Nature Conservation Act 1992 Vulnerable* listed *Eleutheroglossum fellowsii syn Dendrobium fellowsii* was recorded on site at three (3) additional locations in the northeast of the site (**Plate 4**). This species is now located within three (3) Biocondition monitoring plots (see **Figure 3**). This species is an epiphytic orchid found growing in moist windswept environments on the sides of rough barked trees. All populations were located within *Syncarpia glomulifera, Eucalyptus crebra* and *Corymbia intermedia* dominated open forest often containing an understory of *Allocasuarina littoralis* on the top of a high elevation (>1000 m asl) forested ridge facing the predominate southeast cloud moisture.

Plate 4 *E. fellowsii* growing as an epiphyte on *Eucalyptus crebra* at Bio-condition site 12 (December 2021)

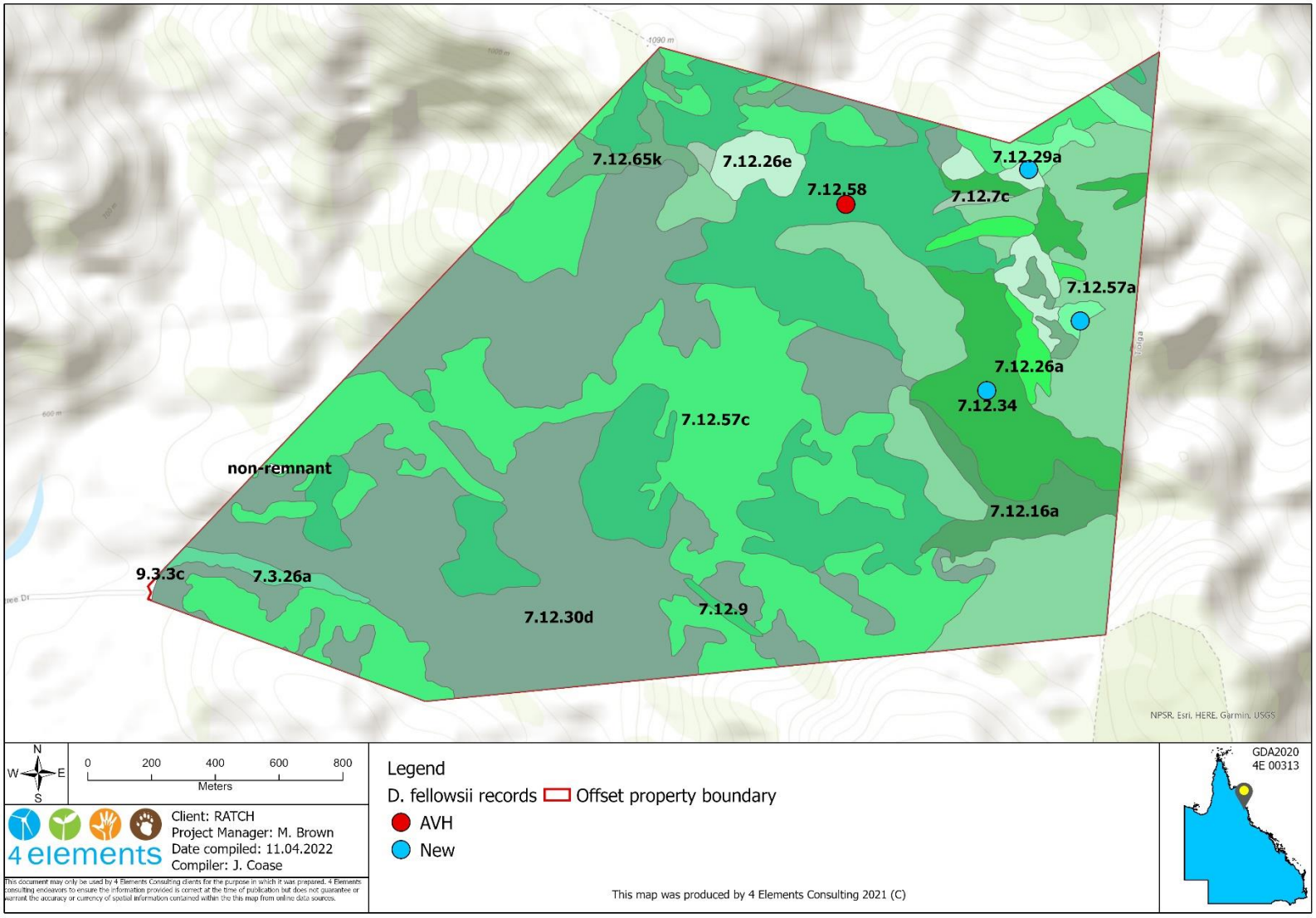


Figure 3 ***Dendrobium fellowsii*** **Indicating Australian Virtual Herbarium (AVH) and New 2022 Record**

3.1.3 Prostanthera clotteniana

The NC Act 1992 listed Endangered *Prostanthera clotteniana* has previously been recorded at two (2) locations within the offset site (see **Figure 4**). Since the previous survey (4 Elements 2020) a further one (1) population was located approximately 500 m to the east of the previous known record (see **Figure 4**). This population contained approximately 50 mature individuals and was in flower and fruit at the time of survey (see **Plate 5**). This new population was in a similar aspect and vegetation community as the original record. Population was located at 720 m asl within RE 7.12.57c on a North facing steep rhyolite slope with a *Callitris intratropica, Acacia disparrima* canopy *Bursaria incana, Grevillea glossadenia, Homoranthus porteri* with a dense *Themeda triandra* ground layer (see **Plate 5**). Previously five (5) records had been located all within RE 7.12.30d.

Plate 5 *Prostanthera clotteniana* Additional Population (-17.20968, 145.39684)

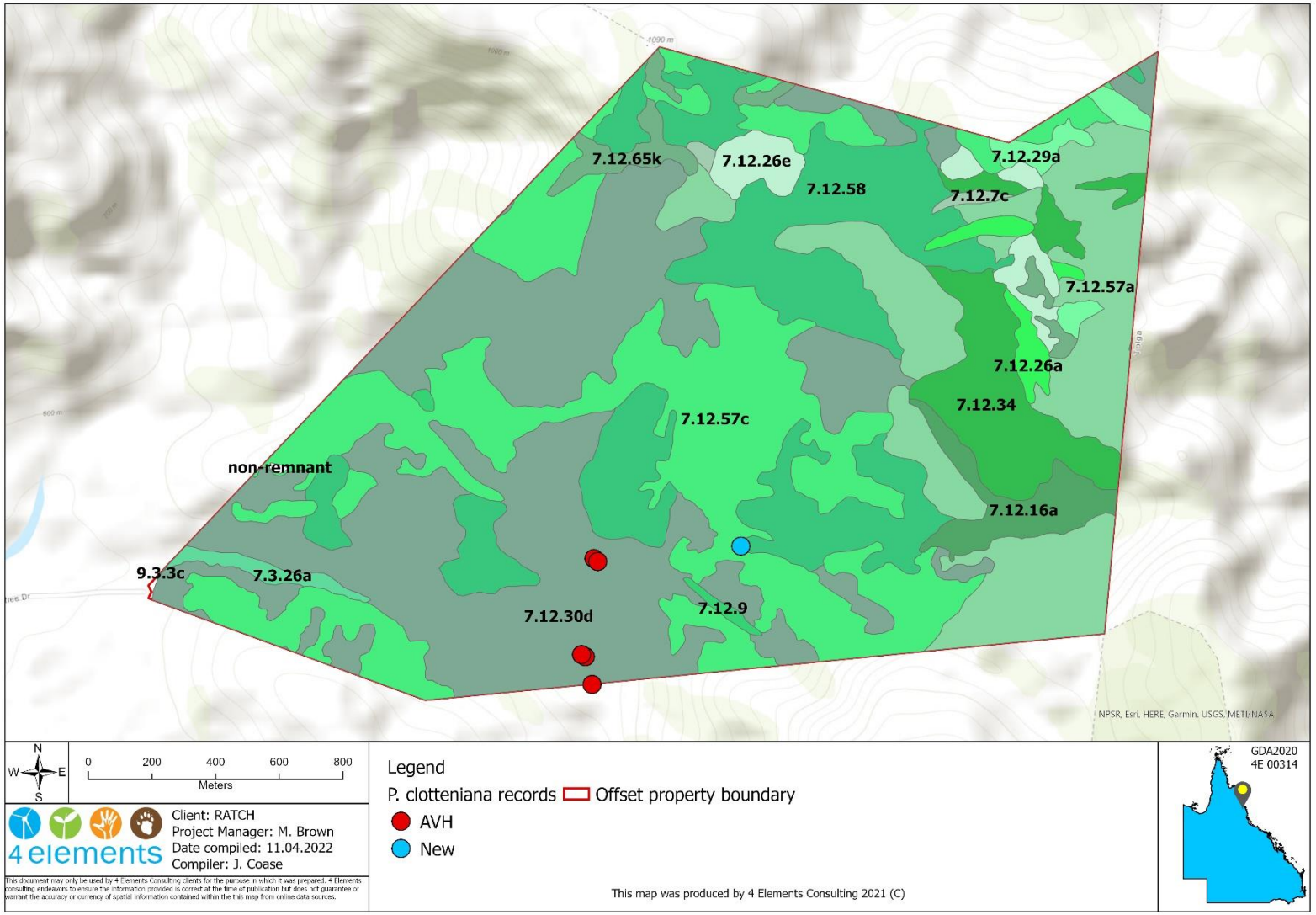


Figure 4 ***Prostanthera clotteniana*** **Indicating Australian Virtual Herbarium (AVH) Records and New 2022 Record**

3.1.4 *Zieria fordii* (Ford's Stink Bush)

This species is listed as Critically Endangered under the Nature Conservation Act 1992. This species was formally described in August 2019 (Duretto, 2019). It is a small shrub to 1.6 m in height with trifoliate leaves in opposite pairs covered in a dense stellate indumentum (see **Plate 6**). This species was split from the widespread and morphologically diverse *Zieria cytisoides* primarily due to the sepals being longer or almost the same length as the petals (2-2.5mm long).

Zieria fordii is known to occur as a single population which is comprised of three (3) sub-populations that occur within 100 ha total extent of occurrence. Many of the individuals recorded previously are within RE 7.12.58 (see **Plate** 7). The entire known global distribution of this species is within the offset site and the property immediately to the east. An additional population was located during the current survey period which increases the known populations to four (4) (see **Figure 4**). The recent additional record consisted of approximately 50 individuals to a height up to 1 m. They were growing under 4-5 m canopy of *Acacia aulacocarpa*, *Pittosporum venulosum, Syncarpia glomulifera*. *Z. fordii* formed part of shrub layer with *Astroloma* sp., *Melaleuca recurva* and *Bertya polystigma*. Dense grassy ground layer on rhyolite ridge southeast facing ridge immediately a vertical drops off to the east.

Plate 6 Close up of *Zieria fordii* Flowers (-17.19704, 145.39415)

Plate 7 *Zieria fordii* Within *Eucalyptus reducta* Woodland February 2022 (-17.19704, 145.39415)

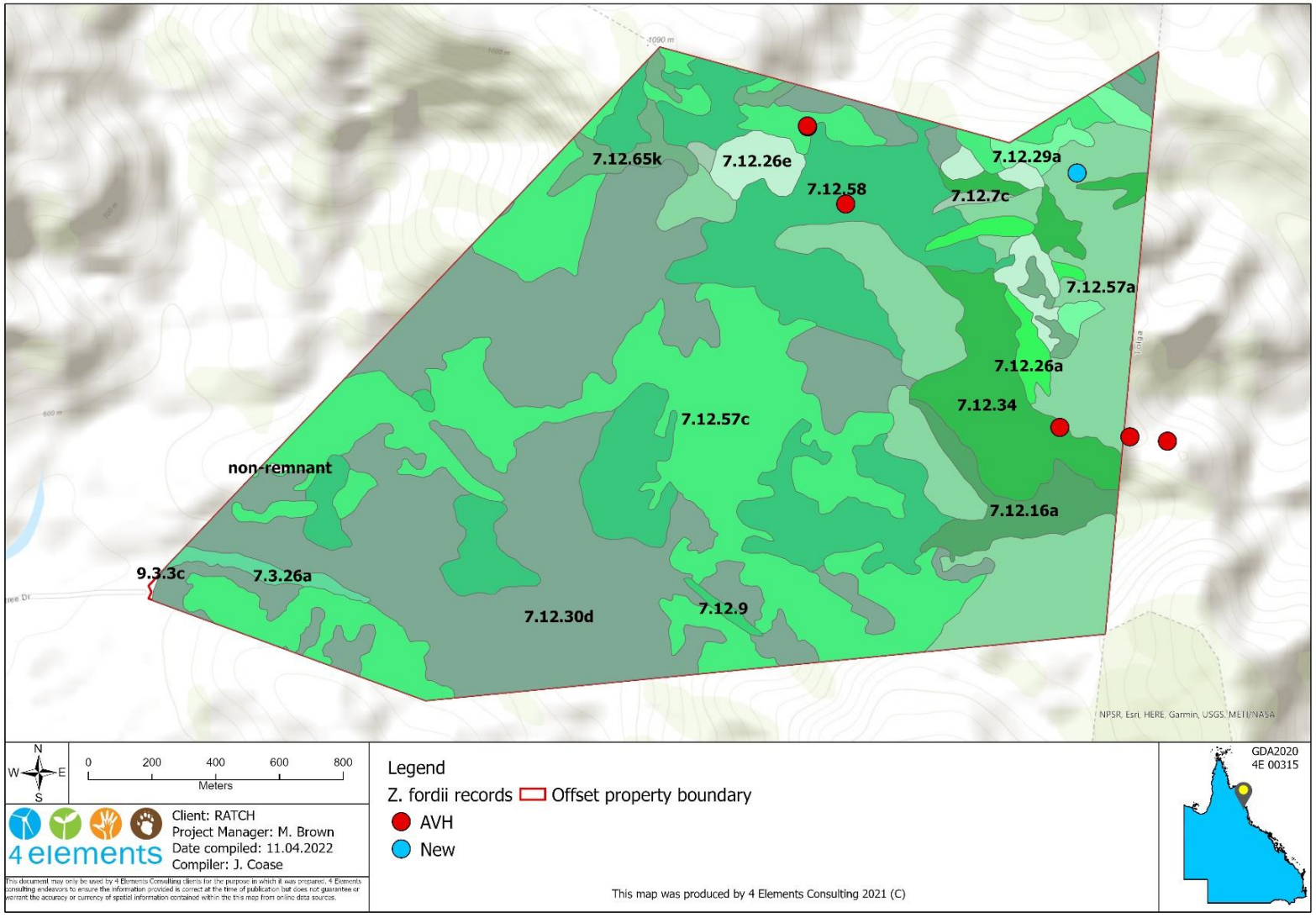


Figure 5 ***Zieria fordii*** **Indicating Australian Virtual Herbarium (AVH) Records and New 2022 Record**

3.1.5 Comesperma anemosmaragdinum

An erect and multibranched perennial shrub to 1.6 m in height. It has concolorous elliptic leaves which are grey green in colour and hairless (see **Plate 8**). This species occurs within RE 7.12.58 and RE 7.12.57c (see **Plate** 9) and is known only from the northern end of the Herberton Range between the Mount Emerald Project Site near to WTG 30 south to Mt Misch (AVH, 2022). The total extent of occurrence is approximately 9 km^2 and with an area of occupancy of less than 1 ha (Ford *et. al.* 2017). This species was first recorded on the offset site in 2009 although was not listed as a threatened species under the *Nature Conservation Act 1992* until September 15, 2020. Therefore, this current survey is the first undertaken where this species has been listed as threatened. No new records of this species were in the current survey.

Plate 8 *Comesperma anemosmaragdinum* Close up of Foliage and Flowers (Bio condition Site 1)

Plate 9 Comesperma anemosmaragdinum Present in the Understory at Bio-condition Site 1

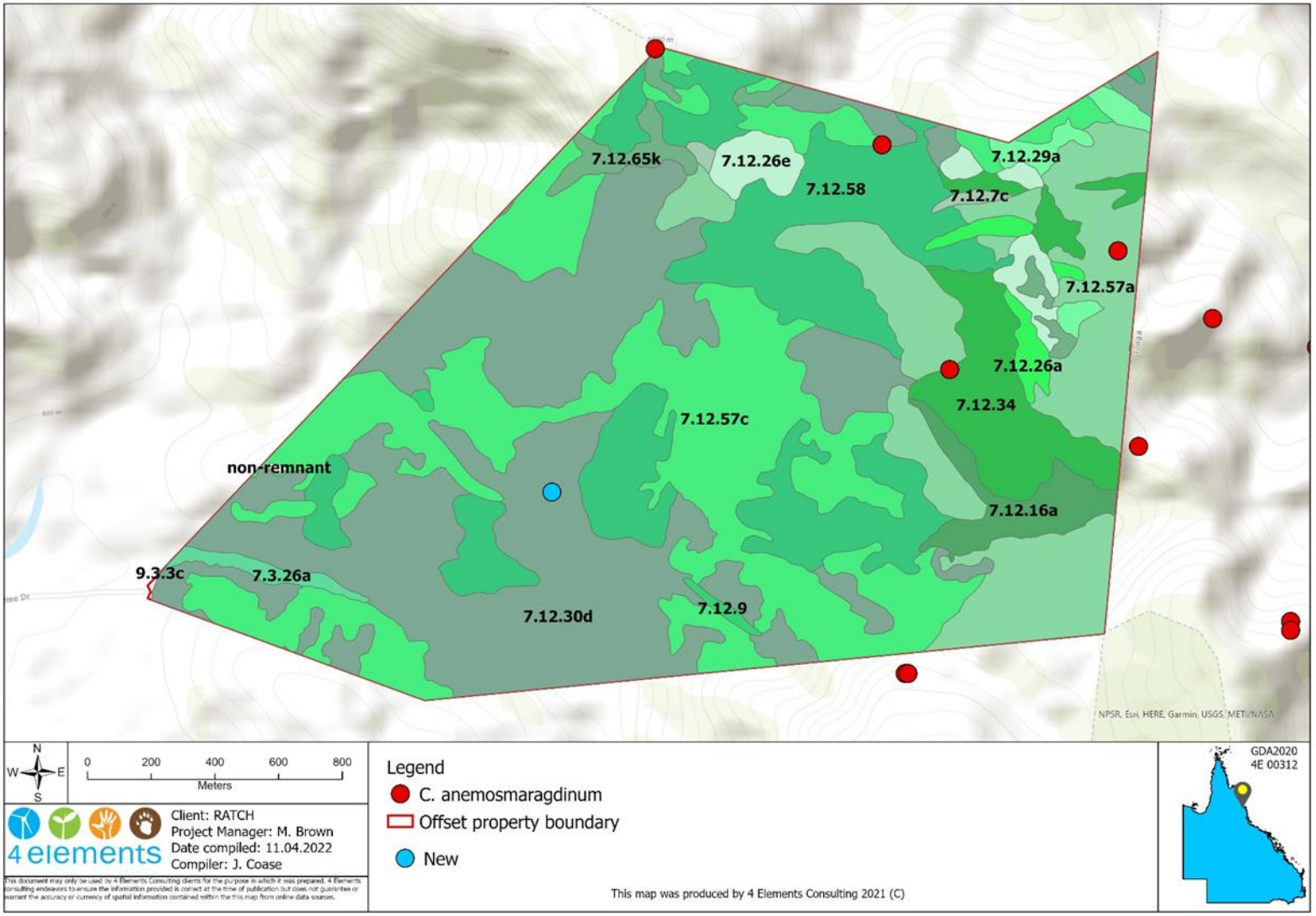


Figure 6 ***Comesperma anemosmaragdinum*** **Indicating Australian Virtual Herbarium (AVH) Records and New 2022 Record**

4.0 Discussion

The Mount Emerald offset site is a biodiversity offset that was gazetted in 2018 as a Nature Refuge under the *Nature Conservation Act 1992*. The site is well selected as an Offset property for the MEWF project which is the neighbouring property located directly to the north. Vegetation communities present on the MEWF project site are represented as are the listed threatened species under both the *EPBC Act 1999* and the *NC Act 1992.* All are represented in healthy populations distributed widely across the site.

Within the 18 bio-condition permanent plots, a total of 11 sites contained listed threatened flora as listed under both state and federal legislation. Threatened species were mostly associated with drier and more structurally open regional ecosystems (7.12.30d, 7.12.57c, 7.12.58 and 7.12.65k). These regional ecosystems are the same as those represented on the MEWF project site where threatened species are clustered. All species that are present within the MEWF site are now included in this bio-condition assessment monitoring plan for the offset site except for *Diuris oporina, Prostanthera clotteniana* and *Melaleuca sylvana*. An additional threatened species, *Eleutheroglossum fellowsii,* listed *Vulnerable* under the *Nature Conservation Act 1992* was recorded in three (3) of the permanent bio-condition sites on this round of bio-condition monitoring. These individuals were found within regional ecosystem 7.12.26e, 7.12.29a and 7.12.34. Conditions for this species are not considered favourable on the MEWF project site due to the prevailing drier and rockier conditions present within that property. There exist numerous locations for this species to occur throughout the high elevation forested peaks of the offset property and further incidental records are likely during the monitoring phase which is to continue biennially until 2028.

No evidence of phytophthora dieback or myrtle rust infection were recorded at any of the 18 bio-condition sites that is common in the lower eastern parts of the wet tropic's bioregion. Non-native flora species were generally very low in abundance and/or absent from many of the sites. Common weeds included *Praxelis clematidea* and *Melinis repens* which are both present across similar habitat across much of the wet tropics due to the ability to wind disperse. Otherwise, ground cover was between 0-1% for herbaceous weeds. No woody weeds have been detected in any of the 18 bio-condition plots. Feral digging was not present at any of the 18 bio-condition sites; however, it was recorded occasionally during site traverse between bio-condition plots.

Due to the lack of reference sites within the wet tropic's bioregion, a bio-condition score for each of the surveyed vegetation communities cannot be achieved currently. Once reference sites are collected and published by the Queensland Herbarium for the regional ecosystems present on the Offset property this may then occur. As was found in the field surveys for the initial site assessment (RPS, 2016) the condition of the offset site is considered in pristine ecological condition with low disturbance recorded and high abundance of threatened flora species. After the completion of three (3) biennial rounds of bio-condition monitoring, this remains the case. Continued biennial monitoring of the 18-permanent bio-condition plots will provide quantitative monitoring of threatened species health and distribution until 2028.

5.0 References

4 Elements (2019) Bio-condition Survey- MEWF Offset Site April 2019. Unpublished report prepared for Ratch Australia Pty.

Duretto, M. F. (2019) *Zieria fordii* and *Z. wilhelminae* (Rutaceae), two new and restricted Queensland species segregated from the morphologically similar an widespread *Z. cytisoides*. *Telopea Journal of Plant Systematics*. (**22**) pp 135-140.

Eyre TJ, Kelly AL and Neldner VJ (2017). Method for the Establishment and Survey of Reference Sites for Bio-condition. Version 3. Queensland Herbarium, Department of Science, Information Technology and Innovation, Brisbane.

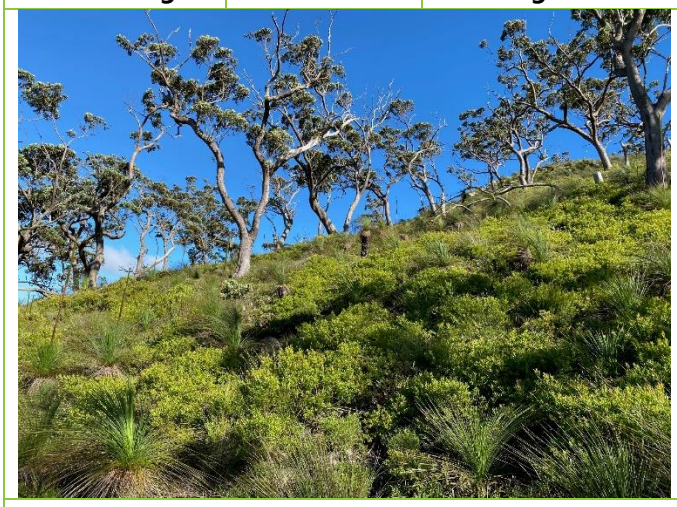
Ford, A. J., Halford, D. A., Van Der Merwe, M. and Mathieson, M. (2017). A revision of the tropical white-flowered species of *Comesperma* (Polygalaceae) in Australia. *CSIRO Publishing Australian Systematic Botany*. 30 (**2**) pp 159-182.

Gleed, S (2018). Mt Emerald Wind Farm Offset Site Bio-condtion Surveys 2018. Unpublished report prepared for Ratch Australia Pty.

Queensland Herbarium (2022). Regional Ecosystem Description Database (REDD). Version 11.1 (April 20 2022). DSITI, Brisbane.

RPS (2016) Offsets Area Management Plan. Mt Emerald Wind Farm, Herberton Range, North Queensland. Unpublished report prepared for Ratch Australia Pty.

Bio-condition Site 1				
Date:	**17-02-2022**			
Plot Origin:	Zone: 55K	Easting: 0329103	Northing: 8097846	Elevation: 1036
Plot Centre:	Zone 55K	Easting: 0329142	Northing: 8097874	Elevation: 1043
Plot Bearing:	NE	**Plot Alignment:**	**Parallel to contour**	



North

East

South

West

Habitat Description:	*Eucalyptus reducta* open woodland with a canopy height ranging from 8-10m. A shrubby understory consisting of *Leptospermum amboinense, Xanthorrhoea johnsonii and Acacia calyculata* 0.5-1m in height. The ground cover species consist of *Cleistochloa subjuncea* and *Lepidosperma laterale* to 0.25m tall.		
Regional Ecosystem (Mapped):	**RE 7.12.58** *Eucalyptus reducta +/- E. granitica +/- Corymbia dimorpha +/- C. citriodora* woodland to open forest on granite and rhyolite.		
Vegetation Attributes:	Recruitment of Dominant Canopy Species (%):		100%
	Native plant species richness:	Trees:	1
		Shrubs:	9
		Grasses:	2

Bio-condition Site 1			
		Forbs/Other:	11
	Tree Canopy	Median Height (m)	9
		Tree Canopy Cover (%)	33.6
	Tree Sub-canopy	Tree sub-canopy median Height (m)	N/A
		Tree Sub-canopy Cover	0
	Large Trees	Large Eucalypt tree DBH threshold (cm)	35
		Large Eucalypt trees per hectare	20
		Large non-eucalypt trees threshold (cm)	NA
		Large non-eucalypt trees per hectare	NA
	Shrub Cover	Native Shrub Layer 1 Cover (%)	3.6
		Native Shrub Layer 2 Cover (%)	38.2
	Ground Cover	Native Perennial Grass Cover (%)	85
		Forbs and Non-grass (%)	2
		Shrubs (%)	46
		Organic litter cover (%)	23
		Rock (%)	8
		Bare Ground (%)	3
		Cryptograms (%)	3
		Non-native plant cover (%)	0
		Total Non-native species richness	0
	Coarse Woody Debris (CWD)	Total length >10cm width and >1m length (m)	98
Native Species Richness:	Trees	*Eucalyptus reducta*	
	Shrubs	*Acacia calyculata, Acrothamnus spathaceus, Comesperma anemosmaragdinum, Exocarpos cupressiformis, Leptospermum amboinense, Persoonia falcata, Platysace valida, Pseudanthus ligulatus, Xanthorrhoea johnsonii*	
	Grasses	*Aristida sp., Cleistochloa subjuncea*	
	Forbs and Others	*Fimbristylis sp., Hovea nana, Pigea enneasperma, Lepidosperma laterale, Lomandra filiformis, Lomandra multiflora, Melichrus urceolatus, Pimelea linearifolia, Pultenaea millarii, Stylidium graminifolium, Tricoryne anceps*	
Non-native Species	Nil		
Threatened flora	*Comesperma anemosmaragdinum*		

Table 2Bio-condition site 2

Bio-condition Site 2				
Date:	**17-02-2022**			
Plot Origin:	Zone: 55K	Lat: 329249	Long: 8097871	Elevation: 1019m
Plot Centre:	Zone: 55K	Lat: 329250	Long: 8097921	Elevation: 1034m
Plot Bearing:	N	**Plot Alignment:**	Upslope across rock pavement	
				
North			East	
				
South			West	
Habitat Description:	Rock pavement community that slopes southward. Shrubland community consisting of *Acacia aulacocarpa, Eucalyptus lockyeri* and *Leptospermum amboinense* as the dominant shrubs on the site.			
Regional Ecosystem (Mapped):	**7.12.65k***:* Granite and rhyolite rock outcrop, of dry western areas, associated with shrublands to closed forests of *Acacia spp.* and/or *Lophostemon spp.* and/or *Allocasuarina spp.* In the Mount Emerald area, shrubs may include *Acacia umbellata, Melaleuca borealis, Homoranthus porteri, Leptospermum neglectum, Melaleuca recurva, Melaleuca uxorum, Grevillea glossadenia, Corymbia abergiana, Eucalyptus lockyeri, Sannantha angusta, Pseudanthus ligulatus subsp. ligulatus, Acacia aulacocarpa, Leptospermum amboinense, Xanthorrhoea johnsonii and Jacksonia*			

Bio-condition Site 2			
	thesioides. Ground-cover species may include Borya septentrionalis, Lepidosperma laterale, Eriachne spp., Cleistochloa subjuncea, Boronia occidentalis, Cheilanthes spp., Coronidium newcastlianum, Schizachyrium spp., Tripogon loliiformis, Gonocarpus acanthocarpus and Eragrostis spp. Dry western areas. Granite and rhyolite. (BVG1M: 29b)		
Vegetation Attributes:	Recruitment of Dominant Canopy Species (%):		100%
	Native plant species richness:	Trees:	2
		Shrubs:	10
		Grasses:	6
		Forbs/Other:	9
	Tree Canopy	Median Height (m)	NA
		Tree Canopy Cover (%)	NA
	Tree Sub-canopy	Tree sub-canopy median Height (m)	NA
		Tree Sub-canopy Cover	NA
	Large Trees	Large Eucalypt tree DBH threshold (cm)	NA
		Large Eucalypt trees per hectare	NA
		Large non-eucalypt trees threshold (cm)	NA
		Large non-eucalypt trees per hectare	NA
	Shrubs	Native Shrub Cover (%)	6.5
	Ground Cover	Native Perennial Grass Cover (%)	0
		Forbs and Non-grass (%)	2
		Shrubs (%)	3
		Organic litter cover (%)	5
		Rock (%)	36
		Bare Ground (%)	NA
		Cryptograms (%)	54
		Non-native plant cover (%)	3
		Total Non-native species richness	1
	Coarse Woody Debris (CWD)	Total length >10cm width and >1m length (m)	0
Native Species Richness:	Trees	*Eucalyptus atrata, E. reducta*	
	Shrubs	*Acacia aulacocarpa, Acrothamnus spathaceus, Astrotricha pterocarpa, Melaleuca recurva, Hibbertia stirlingii, Hibiscus meraukensis, Homoranthus porteri, Seringia lanceolata, Leptospermum amboinense, Plectranthus amoenus.*	

Bio-condition Site 2		
	Grasses	*Aristida sp., Arundinella setosa, Cleistochloa subjuncea, Digitaria sp., Eragrostis schultzii, Urochloa holosericea.*
	Forbs and Others	*Cheilanthes distans, Commelina ensifolia, Baronial occidentalis, Drynaria rigidula, Fimbristylis sp., Gonocarpus acanthocarpus, Hypericum gramineum, Plectranthus parviflorus, Sedopsis sp. Bulimba Station*
Non-native Species		*Praxelis clematidea**
Threatened Flora		*Homoranthus porteri, Plectranthus amoenus*

Table 3Bio-condition site 3

Bio-condition Site 3				
Date:	**17-02-2022**			
Plot Origin:	Zone: 55K	Easting: 329366	Northing: 8097925	Elevation: 1033m
Plot Centre:	Zone: 55K	Easting: 329361	Northing: 8097949	Elevation: 1020m
Plot Bearing:	NNW	**Plot Alignment:**	Upslope across centre of vegetation type	
				
North			East	
				

Bio-condition Site 3			
South		West	
Habitat Description:	Low shrubland/heathland 1-2.5m high with a patchy rock pavement surface. The ground layer occurs at a height of 0.25-0.5m, with the dominant grass species occurring as *Cleistochloa subjuncea*. *Xanthorrhoea johnsonii, Acacia calyculata* and *Eucalyptus lockyeri* are dominant species.		
Regional Ecosystem (Mapped):	**7.12.57c** 7.12.57c: Shrubland/low woodland (1.5-9 m tall) mosaic with variable dominance, often including *Eucalyptus cloeziana, Corymbia abergiana, E. portuensis, E. reducta, E. lockyeri, C. leichhardtii, Callitris intratropica, E. atrata, E. pachycalyx, E. shirleyi, E. drepanophylla* and *Homoranthus porteri*, on rhyolite and granite		
Vegetation Attributes:	Recruitment of Dominant Canopy Species (%):		100%
	Native plant species richness:	Trees:	4
		Shrubs:	12
		Grasses:	1
		Forbs/Other:	21
	Tree Canopy	Median Height (m)	NA
		Tree Canopy Cover (%)	0
	Tree Sub-canopy	Tree sub-canopy median Height (m)	NA
		Tree Sub-canopy Cover	0
	Large Trees	Large Eucalypt tree DBH threshold (cm)	40
		Large Eucalypt trees per hectare	4
		Large non-eucalypt trees threshold (cm)	0
		Large non-eucalypt trees per hectare	0
	Shrubs	Native Shrub Layer 1 Cover (%)	0.9
		Native Shrub Layer 2 Cover (%)	13.3
	Ground Cover	Native Perennial Grass Cover (%)	48
		Forbs and Non-grass (%)	1
		Shrubs (%)	17
		Organic litter cover (%)	7
		Rock (%)	21
		Bare Ground (%)	0
		Cryptograms (%)	3
		Non-native plant cover (%)	3
		Total Non-native species richness	0
	Coarse Woody Debris (CWD)	Total length >10cm width and >1m length (m)	0
Native Species Richness:	Trees	*Allocasuarina inophloia, Eucalyptus drepanophylla, Eucalyptus lockyeri, Eucalyptus reducta*	

Bio-condition Site 3		
	Shrubs	*Acacia calyculata, Acrothamnus spathes, Alphitonia excelsa, Astrotricha pterocarpa, Hakea benthamii, Hibbertia styling, Hibiscus normanii, Leptospermum amboinense, Persoonia falcata, Platysace valida, Sannantha angusta, Xanthorrhoea johnsonii*
	Grasses	*Cleistochloa subjuncea, Cymbopogon bombycinus, Eragrostis sp., Eriachne mucronata, Panicum simile, Schizachyrium fragile, Themeda triandra, Tripogon loliiformis*
	Forbs and Others	*Boea hygroscopica, Boronia occidentalise, Cheilanthes brownii, Cheilanthes distans, Cheilanthes nudiuscula, Coronidium newcastlianum, Dianella nervosa, Drosera lunata, Fimbristylis dichotoma, Gonocarpus acanthocarpus, Habanera elongata, Heliotropium tabuliplagae, Hibbertia longifolia, Hypericum gramineum, Lepidosperma laterale, Melichrus adpressus, Peripleura diffusa, Phyllanthus dallachyana, Schoenus sp., Stylidium gramineum, Tricoryne anceps.*
Non-native Species		Nil
Threatened Flora		Nil

Table 4Bio-condition site 4

Bio-condition site 4				
Date:	**01-04-2022**			
Plot Origin:	Zone: 55K	Lat: -17.21282	Long: 145.39218	Elevation: 1036m
Plot Centre:	Zone: 55K	Lat: -17.21256,	Long: 145.39212	Elevation: 1036m
Plot Bearing:	S	**Plot Alignment:**	Along contour of hillslope. North-south orientation.	

Bio-condition site 4	
	
North	East
	
South	West
Habitat Description:	Steep hillslope of dry open forest/woodland. The dominant tree species consist of *Eucalyptus cloeziana, Eucalyptus pachycalyx, Callitris intratropica* and *Allocasuarina inophloia* in the sub canopy. The shrub layer is sparse with a thicker grass layer. Grass layer consists largely of *Triodia microstachya* and *Cleistochloa subjuncea* with a shrub layer of mostly of *Acacia calyculata* and *Hibbertia stirlingii.*
Regional Ecosystem (Mapped):	**7.12.30d**: Open woodland to open forest (10-20m tall) mosaic with variable dominance, often including *Eucalyptus cloeziana, C. citriodora, E. portuensis, E. lockyeri, C. leichhardtii, E. atrata, E. pachycalyx, E. reducta, C. intermedia and E. shirleyi.* There is often a very sparse to mid-dense secondary tree layer of *C. abergiana and/or C. stockeri*. A very sparse to sparse tall shrub layer may be present and can include *Acacia flavescens, Persoonia falcata, Bursaria spinosa subsp. spinosa, Allocasuarina inophloia, Petalostigma pubescens* and *Grevillea glauca.* A sparse to dense lower shrub layer may include *Jacksonia thesioides, Acacia calyculata, Xanthorrhoea johnsonii* and *Grevillea glossadenia*. The ground layer may be dominated by species such as *Themeda triandra, Heteropogon triticeus,*

Bio-condition site 4			
	Mnesithea rottboellioides, Arundinella setosa, Cleistochloa subjuncea, Eriachne pallescens var. pallescens, Lepidosperma laterale and Xanthorrhoea johnsonii. Rocky slopes on granite and rhyolite. (BVG1M: 9d).		
Vegetation Attributes:	Recruitment of Dominant Canopy Species (%):		100
	Native plant species richness:	Trees:	7
		Shrubs:	21
		Grasses:	6
		Forbs/Other:	10
	Tree Canopy	Median Height (m)	10
		Tree Canopy Cover (%)	32.1
	Tree Sub-canopy	Tree sub-canopy median Height (m)	NA
		Tree Sub-canopy Cover	NA
	Large Trees	Large Eucalypt tree DBH threshold (cm)	35
		Large Eucalypt trees per hectare	10
		Large non-eucalypt trees threshold (cm)	23
		Large non-eucalypt trees per hectare	4
	Shrubs	Native Shrub Cover (%)	31.3
	Ground Cover	Native Perennial Grass Cover (%)	25
		Forbs and Non-grass (%)	4
		Shrubs (%)	16
		Organic litter cover (%)	40
		Rock (%)	15
		Bare Ground (%)	0
		Cryptograms (%)	0
		Non-native plant cover (%)	<1
		Total Non-native species richness	1
	Coarse Woody Debris (CWD)	Total length >10cm width and >1m length (m)	90
Native Species Richness:	Trees	*Allocasuarina inophloia, Eucalyptus cloeziana, Eucalyptus crebra, Eucalyptus pachycalyx, Callitris intratropica, Corymbia erythrophloia, Corymbia leichhardtii*	
	Shrubs	*Acacia calyculata, Acacia multisiliqua, Acacia nesophila, Acacia umbellata, Bursaria incana, Capparis canescens, Dodonaea lanceolata, Exocarpos cupressiformis, Gompholobium nitidum, Grevillia glossadenia, Hibbertia stirlingii, Hibbertia longifolia,*	

Bio-condition site 4		
		Jacksonia thesioides, Larsenaikia ochreata, Persoonia falcata, Petalostigma banksii, Psydrax attenuata, Thaumastochloa major, Xanthorrhoea johnsonii.
	Grasses	*Arundinella setosa, Cleistochloa subjuncea, Cymbopogon sp., Panicum simile, Themeda triandra, Triodia microstachya.*
	Forbs and Others	*Cheilanthes nitida, Cyanthilium cinereum, Dianella nervosa, Goodenia spathulata, Gonocarpus acanthocarpus, Iphigenia indica, Phyllanthus simplex, Poranthera microphylla., Scleria brownii*
Non-native Plant Species		*Praxelis clematidea*
Threatened Flora		*Acacia purpureopetala, Grevillea glossadenia*

Table 5Bio-condition site 5

Bio-condition Site 5				
Date:	**04-03-2022**			
Plot Origin:	Zone: 55K	easting: 329465	northing: 8096347	Elevation: 725m
Plot Centre:	Zone: 55K	easting: 3294483	northing: 8096336	Elevation: 726m
Plot Bearing:	**W**	**Plot Alignment:**	Upslope through a boulder strewn gully	
				
North			East	
				
South			West	

Habitat Description:	Dry vine forest within a rocky granite gully.		
Regional Ecosystem (Mapped):	**7.12.9** *Acacia celsa* open forest to closed forest. Foothills, uplands and highlands on granites and rhyolites, of the very wet and wet rainfall zone. (BVG1M: 5d)		
Vegetation Attributes:	Recruitment of Dominant Canopy Species (%):		100%
	Native plant species richness:	Trees:	11
		Shrubs:	14
		Grasses:	4
		Forbs/Other:	13
	Tree Canopy	Median Height (m)	16
		Tree Canopy Cover (%)	20.8

Bio-condition Site 5			
	Tree Sub-canopy	Tree sub-canopy median Height (m)	8
		Tree Sub-canopy Cover	6.2
	Large Trees	Large Eucalypt tree DBH threshold (cm)	Nil
		Large Eucalypt trees per hectare	Nil
		Large non-eucalypt trees threshold (cm)	28
		Large non-eucalypt trees per hectare	32
	Shrubs	Native Shrub Cover (%)	0.7
	Ground Cover	Native Perennial Grass Cover (%)	14.2
		Forbs and Non-grass (%)	25
		Shrubs (%)	0
		Organic litter cover (%)	16.8
		Rock (%)	41
		Bare Ground (%)	3
		Cryptograms (%)	0
		Non-native plant cover (%)	<1
		Total Non-native species richness	3
	Coarse Woody Debris (CWD)	Total length >10cm width and >1m length (m)	21.3
Native Species Richness:	Trees	*Acronychia laevis, Atractocarpus fitzalanii, Bursaria tenuifolia, Callitris intratropica, Chionanthus ramiflorus, Davidsonia pruriens, Drypetes deplanchei, Euroschinus falcata, Ficus rubiginosa, Ficus virens, Homalium circumpinnatum, Gossia bidwillii, Ligustrum australianum, Myrsine variabilis Olea paniculata Pleiogynium timorense, Pittosporum venulosum, Sersalisia sericea.*	
	Shrubs	*Alchornea sp., Alyxia ruscifolia, Bursaria spinosa, Canarium australianum, Elaeodendron melanocarpum, Euroschinus falcata, Ficus rubiginosa, Ficus virens, Hibiscus meraukensis, Myrsine variabilis, Polyscias elegans, Psydrax dallachiana, Sersalisia sericea, Wikstroemia indica*	
	Grasses	*Arundinella setosa, Oplismenus compositus, Ottochloa sp., Themeda triandra,*	
	Forbs and Others	*Adiantum aethiopicum, Asystasia sp., Cissus oblonga, Commelina ensifolia, Dioscorea bulbifera, Dioscorea transversa, Paraceterach muelleri, Phyllanthus simplex, Plectranthus amoenus, Plectranthus sp.,*	

Bio-condition Site 5		
		Proiphys amboinense, Scleria mackaviensis, Tectaria confluens
Non-native species		*Praxelis clematidea, Lantana camara, Solanum seaforthianum*
Threatened Flora		*Plectranthus amoenus*

Table 6Bio-condition Site 6

Bio-condition Site 6				
Date:	**11-02-2022**			
Plot Origin:	Zone: 55K	easting: 330389	northing: 8096572	Elevation: 793m
Plot Centre:	Zone: 55K	easting: 330409	northing: 8096598	Elevation: 792m
Plot Bearing:	E	**Plot Alignment:**	Crosses braided watercourse channel.	
				
North			East	
				
South			West	
Habitat Description:	Vine forest across rocky stream and terrace.			

Bio-condition Site 6			
Regional Ecosystem (Mapped):	**7.12.16a***:* Simple notophyll vine forest on wet and moist uplands, granite and rhyolite. Uplands of the cloudy wet to moist rainfall zones. Granite and rhyolite. (BVG1M: 6b)		
Vegetation Attributes:	Recruitment of Dominant Canopy Species (%):		100%
	Native plant species richness:	Trees:	10
		Shrubs:	6
		Grasses:	1
		Forbs/Other:	15
	Tree Canopy	Median Height (m)	17
		Tree Canopy Cover (%)	91.2
	Tree Sub-canopy	Tree sub-canopy median Height (m)	10
		Tree Sub-canopy Cover	24
	Large Trees	Large Eucalypt tree DBH threshold (cm)	NA
		Large Eucalypt trees per hectare	0
		Large non-eucalypt trees threshold (cm)	28
		Large non-eucalypt trees per hectare	10
	Shrubs	Native Shrub Cover (%)	12.4
	Ground Cover	Native Perennial Grass Cover (%)	1
		Forbs and Non-grass (%)	16
		Shrubs (%)	5
		Organic litter cover (%)	32
		Rock (%)	34
		Bare Ground (%)	2
		Cryptograms (%)	10
		Non-native plant cover (%)	<1
		Total Non-native species richness	1
	Coarse Woody Debris (CWD)	Total length >10cm width and >1m length (m)	36
Native Species Richness:	Trees	*Agathis robusta, Atractocarpus fitzalanii, Chionanthus grandiflora, Drypetes deplanchei, Elaeodendron melanocarpum, Gossia bidwillii, Mallotus philippensis, Olea paniculata, Pleiogynium timorense, Sersalisia sericea*	
	Shrubs	*Alyxia ruscifolia, Alyxia spicata, Alectryon tomentosus, Homalium cur, Melodinus australis, Psychotria dallachiana*	
	Grasses	*Ottochloa gracillima*	

Bio-condition Site 6		
	Forbs and Others	*Adiantum hispidulum, Adiantum atroviride, Boea sp., Cymbidium madidum, Drynaria sparsisora, Geitonoplesium sp., Microsorum punctatum, Parsonsia sp., Plectranthus mirus, Proiphys amboinensis, Pseuderanthemum variabile, Scleria mackaviensis, Wikstroemia indica*
Non-native Species		*Praxelis clematidea*
Threatened Flora		Nil

Table 7Bio-condition Site 7

Bio-condition Site 7				
Date:	**14-04-2022**			
Plot Origin:	Zone: 55K	easting: 328005	northing: 8096481	Elevation: 596m
Plot Centre:	Zone: 55K	easting: 328056	northing: 8096475	Elevation: 596m
Plot Bearing:	SE	**Plot Alignment:**	Upstream between ephemeral stream beds	
				
North			East	
				

Bio-condition Site 7			
South		West	
Habitat Description:	Braided seasonal watercourse with sandy and rocky bars. *Eucalyptus tereticornis* dominant, 15m high. Subcanopy of *Callitris intratropica, Acacia disparrima* at 1-4m high. Grassy ground layer, 0.5m high.		
Regional Ecosystem (Mapped):	**7.3.26a** *Casuarina cunninghamiana, Eucalyptus tereticornis, Lophostemon suaveolens, Melaleuca leucadendra, M. fluviatilis, Buckinghamia celsissima, Mallotus philippensis* woodland and forest with an understorey of *Melaleuca viminalis* and *Bursaria tenuifolia.* Fringing forests of larger streams. Riverine wetland or fringing riverine wetland. (BVG1M: 16a).		
Vegetation Attributes:	Recruitment of Dominant Canopy Species (%):		100%
	Native plant species richness:	Trees:	16
		Shrubs:	17
		Grasses:	13
		Forbs/Other:	14
	Tree Canopy	Median Height (m)	15
		Tree Canopy Cover (%)	30.8
	Tree Sub-canopy	Tree sub-canopy median Height (m)	7
		Tree Sub-canopy Cover	14.5
	Large Trees	Large Eucalypt tree DBH threshold (cm)	45
		Large Eucalypt trees per hectare	16
		Large non-eucalypt trees threshold (cm)	24
		Large non-eucalypt trees per hectare	8
	Shrubs	Native Shrub Cover (%)	6.3
	Ground Cover	Native Perennial Grass Cover (%)	42
		Forbs and Non-grass (%)	2
		Shrubs (%)	2
		Organic litter cover (%)	20
		Rock (%)	19
		Bare Ground (%)	8.6
		Cryptograms (%)	0
		Non-native plant cover (%)	6.4
		Total Non-native species richness	4
	Coarse Woody Debris (CWD)	Total length >10cm width and >1m length (m)	30.5
Native Species Richness:	Trees	*Acacia disparrima, Acacia flavescens, Alphitonia excelsa, Bursaria tenuifolia, Corymbia leichhardtii, Corymbia erythrophloia, Corymbia clarksoniana, Callitris*	

Bio-condition Site 7		
		intratropica, Canarium australianum, Eucalyptus crebra, Eucalyptus tereticornis, Grevillea parallela, Larsenaikia ochreata, Lophostemon grandiflora, Sersalisia sericea, Santalum lanceolatum
	Shrubs	*Acacia nesophila, Breynia oblongifolia, Cajanus acerifolius, Clerodendrum longiflorum, Crotalaria brevis, Dodonaea lanceolata, Dodonaea dodecandra, Drypetes deplanchei, Exocarpos latifolius, Ficus opposita, Grevillea glossadenia, Grewia mesomischa, Hibiscus meraukensis, Homalium brachybotrys, Petalostigma pubescens, Pimelea confertifolia, Trema aspera*
	Grasses	*Aristida sp., Arundinella nepalensis, Arundinella setosa, Cleistochloa subjuncea, Cymbopogon ambiguus, Digitaria sp., Heteropogon contortus, Heteropogon triticeus, Panicum effusum, Panicum simile, Sarga plumosum, Setaria surgens, Themeda triandra*
	Forbs and Others	*Camel bush, Commelina ensifolia, Cyanthillium cinereum, Dianella nervosa, Flemingia parviflora, Geitonoplesium cymosum, Hibbertia longifolia, Lomandra longifolia, Poranthera microphylla, Phyllanthus dallachyanus, Scleria brownii, Tricoryne anceps, Waltheria indica. Wikstroemia indica*
Non-native Species		*Praxelis clematidea, Melinis minutiflora, Lantana camara, Melinis repens, Themeda quadrivalvis*
Threatened Flora		*Grevillea glossadenia*

Table 8Bio-condition site 8

Bio-condition Site 8				
Date:	**01-04-2022**			
Plot Origin:	Zone: 55K	easting: 328826	northing: 8096354	Elevation: 630m
Plot Centre:	Zone: 55K	easting: 328788	northing: 8096345	Elevation: 624m
Plot Bearing:	SW	**Plot Alignment:**	Parallel with contour of rounded hill.	

<table>
<tr><th colspan="4">Bio-condition Site 8</th></tr>
<tr><td colspan="2">  </td><td colspan="2">  </td></tr>
<tr><td colspan="2">North</td><td colspan="2">East</td></tr>
<tr><td colspan="2">  </td><td colspan="2">  </td></tr>
<tr><td colspan="2">South</td><td colspan="2">West</td></tr>
<tr><td>Habitat Description:</td><td colspan="3">Grassy woodland open woodland with Eucalyptus cloeziana and Corymbia leichhardtii dominant trees, 9-11m tall. Subcanopy consists of Callitris intratropica and Acacia disparrima 4-5m tall. Shrub layer 0.5-1.5m tall. Ground cover to half a metre.</td></tr>
<tr><td>Regional Ecosystem (Mapped):</td><td colspan="3">7.12.30d Open woodland to open forest (10-20m tall) mosaic with variable dominance, often including Eucalyptus cloeziana, C. citriodora, E. portuensis, E. lockyeri, C. leichhardtii, E. atrata, E. pachycalyx, E. reducta, C. intermedia and E. shirleyi.</td></tr>
<tr><td rowspan="6">Vegetation Attributes:</td><td colspan="2">Recruitment of Dominant Canopy Species (%):</td><td>N/A</td></tr>
<tr><td rowspan="4">Native plant species richness:</td><td>Trees:</td><td>5</td></tr>
<tr><td>Shrubs:</td><td>23</td></tr>
<tr><td>Grasses:</td><td>10</td></tr>
<tr><td>Forbs/Other:</td><td>21</td></tr>
<tr><td>Tree Canopy</td><td>Median Height (m)</td><td>10</td></tr>
</table>

Bio-condition Site 8			
		Tree Canopy Cover (%)	54.6
	Tree Sub-canopy	Tree sub-canopy median Height (m)	5
		Tree Sub-canopy Cover	3.6
	Large Trees	Large Eucalypt tree DBH threshold (cm)	35
		Large Eucalypt trees per hectare	12
		Large non-eucalypt trees threshold (cm)	23
		Large non-eucalypt trees per hectare	4
	Shrubs	Native Shrub Cover (%)	10.4
	Ground Cover	Native Perennial Grass Cover (%)	15
		Forbs and Non-grass (%)	4
		Shrubs (%)	17
		Organic litter cover (%)	21
		Rock (%)	16
		Bare Ground (%)	25
		Cryptograms (%)	0
		Non-native plant cover (%)	2
		Total Non-native species richness	1
	Coarse Woody Debris (CWD)	Total length >10cm width and >1m length (m)	38
Native Species Richness:	Trees	*Callitris intratropica, Corymbia erythrophloia, Corymbia leichhardtii, Eucalyptus cloeziana, Eucalyptus shirleyi*	
	Shrubs	*Acacia calyculata, Acacia flavescens, Acacia humifusa Acacia multisiliqua, Acacia simsii, Alphitonia excelsa Breynia oblongifolia, Capparis canescens, Clerodendrum longiflorum, Coelospermum reticulatum, Denhamia cunninghamiana, Dodonaea lanceolata, Gastrolobium grandiflorus, Goodenia pubescens, Grevillea glossadenia, Hibbertia stirlingii, Jacksonia thesioides, Persoonia falcata, Pimelea confertifolia, Planchonia careya, Santalum lanceolatum, Wikstroemia indica, Xanthorrhoea johnsonii*	
	Grasses	*Alloteropsis semialata, Aristida sp., Arundinella setosa, Cleistochloa subjuncea, Cymbopogon bombycinus, Digitaria sp., Heteropogon triticeus, Panicum simile, Schizachyrium fragile, Themeda triandra*	

Bio-condition Site 8		
	Forbs and Others	*Bidens pilosa, Cheilanthes nitidum, Clematicissus opaca, Commelina ensifolia, Coronidium newcastlianum, Crotalaria brevis, Cyanthillium cinereum, Dianella nervosa, Glycine clandestina, Gompholobium nitidum, Hibbertia longifolia, Iphigenia indica, Lomandra confertifolia, Phyllanthus simplex, Pigea stellarioides, Poranthera microphylla, Scleria brownii, Tephrosia juncea, Tricoryne anceps, Wahlenbergia queenslandica, Zornia sp.*
Non-native Plant Species		*Praxelis clematidea*
Threatened Flora		*Grevillea glossadenia*

Table 9Bio-condition Site 9

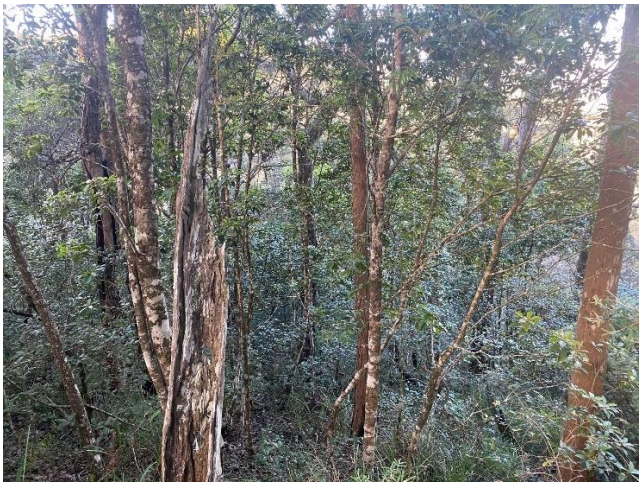
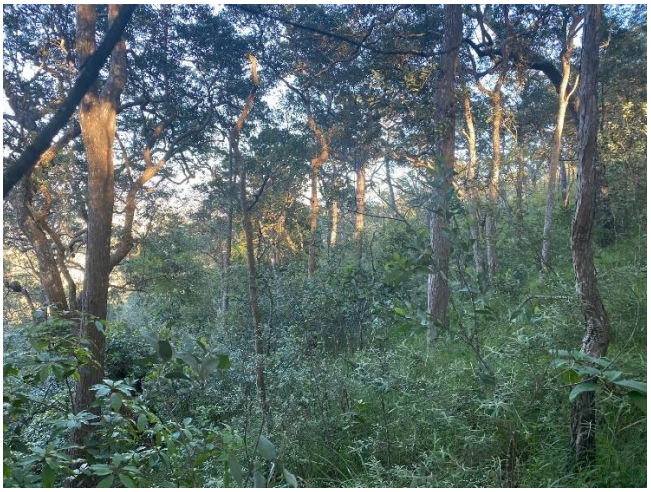
Bio-condition Site 9				
Date:	**13-04-2022**			
Plot Origin:	Zone: 55K	Lat: 17.19718	Long: 145.40770	Elevation: 984m
Plot Centre:	Zone 55K	Lat: 17.19741	Long: 145.40807	Elevation: 980m
Plot Bearing:	SW	**Plot Alignment:**	Mid-slope running parallel to the hill contour.	
				
North			East	

Bio-condition Site 9			
			
South		West	
Habitat Description:	Open forest with a canopy dominated by *Corymbia intermedia*, *Eucalyptus drepanophylla* and *Eucalyptus tereticornis*. Sparse shrub layer (5m) contains *Allocasuarina littoralis*, *Acacia flavescens* and *Lophostemon suaveolens*. Grassy understorey (<1.5m) of *Themeda triandra* and *Mnesithea rottboellioides*.		
Regional Ecosystem (Mapped):	**RE 7.12.29a** *Corymbia intermedia* and/or *Lophostemon suaveolens* open forest to woodland +/- areas of *Allocasuarina littoralis* and *A. torulosa* on uplands on granite and rhyolite.		
Vegetation Attributes:	Recruitment of Dominant Canopy Species (%):		100%
	Native plant species richness:	Trees:	5
		Shrubs:	9
		Grasses:	7
		Forbs/Other:	21
	Tree Canopy	Median Height (m)	9
		Tree Canopy Cover (%)	26.0
	Tree Sub-canopy	Tree sub-canopy median Height (m)	N/A
		Tree Sub-canopy Cover	N/A
	Large Trees	Large Eucalypt tree DBH threshold (cm)	30
		Large Eucalypt trees per hectare	14
		Large non-eucalypt trees threshold (cm)	20
		Large non-eucalypt trees per hectare	6
	Shrubs	Native Shrub Cover (%)	6.6
	Ground Cover	Native Perennial Grass Cover (%)	67
		Forbs and Non-grass (%)	8
		Shrubs (%)	2
		Organic litter cover (%)	6

Bio-condition Site 9			
		Rock (%)	10
		Bare Ground (%)	6
		Cryptograms (%)	0
		Non-native plant cover (%)	1
		Total Non-native species richness	1
	Coarse Woody Debris (CWD)	Total length >10cm width and >1m length (m)	180
Native Species Richness:	Trees	*Allocasuarina littoralis, Corymbia intermedia, Eucalyptus drepanophylla, Eucalyptus tereticornis, Eucalyptus reducta*	
	Shrubs	*Acacia calyculata, Acacia flavescens, Alphitonia excelsa, Breynia oblongifolia, Capparis canescens, Coelospermum reticulatum, Lophostemon suaveolens, Pimelea sericostachya, Xanthorrhoea johnsonii*	
	Grasses	*Arundinella setosa, Capillipedium spicigerum, Heteropogon triticeus, Mnesithea rottboellioides, Panicum simile, Sarga plumosum, Themeda triandra.*	
	Forbs and Others	*Adiantum hispidulum, Commelina ensifolia, Coronidium newcastlianum, Cyanthillium cinereum, Crotalaria brevis, Desmodium rhytidophyllum, Dianella nervosa, Drynaria rigidula, Flemingia parviflora, Glycine clandestina, Hibbertia longifolia, Lomandra filiformis, Phyllanthus simplex, Lepidosperma laterale, Pteridium esculentum, Poranthera microphylla, Rostellularia adscendens, Scleria mackaviensis, Apowollastonia spilanthoides, Indigofera bancroftii, Xerochrysum bracteatum*	
Non-native Species	*Praxelis clematidea*		
Threatened Flora	Nil		

Table 10 Bio-condition Site 10

Bio-condition Site 10				
Date:	**29-05-2020**			
Plot Origin:	Zone: 55K	Lat: 17.19918	Long: 145.40564	Elevation: 1061m
Plot Centre:	Zone: 55K	Lat: 17.19905	Long: 145.4540	Elevation: 1062m
Plot Bearing:	SW	**Plot Alignment:**	Mid-slope running parallel to the hill contour	

<table>
<tr><th colspan="4">Bio-condition Site 10</th></tr>
<tr><td colspan="2">  </td><td colspan="2">  </td></tr>
<tr><td colspan="2">North</td><td colspan="2">East</td></tr>
<tr><td colspan="2">  </td><td colspan="2">  </td></tr>
<tr><td colspan="2">South</td><td colspan="2">West</td></tr>
<tr><td>Habitat Description:</td><td colspan="3">Open forest with a canopy (11m) dominated by Syncarpia glomulifera with occasional Eucalyptus drepanophylla. Open shrub layer (5m) contains Acacia aulacocarpa and Leptospermum amboinense. Grassy understorey (0.5m) of Entolasia stricta and Ottochloa sp.</td></tr>
<tr><td>Regional Ecosystem (Mapped):</td><td colspan="3">7.12.26e Syncarpia glomulifera low open forest and low woodland. Uplands on steep rocky slopes, of the moist and dry rainfall zone. Granite and rhyolite.</td></tr>
<tr><td rowspan="7">Vegetation Attributes:</td><td colspan="2">Recruitment of Dominant Canopy Species (%):</td><td>100%</td></tr>
<tr><td rowspan="4">Native plant species richness:</td><td>Trees:</td><td>2</td></tr>
<tr><td>Shrubs:</td><td>18</td></tr>
<tr><td>Grasses:</td><td>5</td></tr>
<tr><td>Forbs/Other:</td><td>27</td></tr>
<tr><td rowspan="2">Tree Canopy</td><td>Median Height (m)</td><td>11</td></tr>
<tr><td>Tree Canopy Cover (%)</td><td>55.5</td></tr>
<tr><td>Tree Sub-canopy</td><td>Tree sub-canopy median Height (m)</td><td>8</td></tr>
</table>

Bio-condition Site 10			
		Tree Sub-canopy Cover	7.5
	Large Trees	Large Eucalypt tree DBH threshold (cm)	30
		Large Eucalypt trees per hectare	12
		Large non-eucalypt trees threshold (cm)	30
		Large non-eucalypt trees per hectare	24
	Shrubs	Native Shrub Cover (%)	26.0
	Ground Cover	Native Perennial Grass Cover (%)	38
		Forbs and Non-grass (%)	20
		Shrubs (%)	0
		Organic litter cover (%)	29
		Rock (%)	2
		Bare Ground (%)	11
		Cryptograms (%)	0
		Non-native plant cover (%)	<1
		Total Non-native species richness	1
	Coarse Woody Debris (CWD)	Total length >10cm width and >1m length (m)	80
Native Species Richness:	Trees	*Syncarpia glomulifera, Eucalyptus drepanophylla*	
	Shrubs	*Acacia aulacocarpa, Acrothamnus spathaceus, Alyxia spicata, Bertya polystigma, Astrotricha pterocarpa, Bursaria spinosa, Seringia lanceolata, Psychotria loniceroides, Pittosporum venulosum, Pomaderris argyrophylla, Wikstroemia indica, Clerodendrum longiflora, Glochidion sumatranum, Notelaea venosa, Leptospermum amboinense, Rhodamnia sp., Wilkiea sp., Denhamia bilocularis*	
	Grasses	*Entolasia stricta, Oplismenus aemulus, Ottochloa gracimila, Panicum effusum, Panicum simile*	
	Forbs and Others	*Acianthus borealis, Adiantum aethiopicum, Adiantum hispidulum, Bulbophyllum sp., Cheilanthes brownii, Clematis pickeringii, Coronidium rupicola, Corybas sp., Eleutheroglossum fellowsii, Drynaria rigidula, Geitonoplesium cymosum, Lindsaea microphylla, Lepidosperma laterale, Lomandra multiflora, Parsonsia straminea, Plectranthus hirtus, Plectranthus mirus, Plexaure crassula, Pterostylis stricta, Scleria mackaviensis, Smilax australis, Smilax calophylla, Tricoryne anceps, Viola hederacea, Apowollastonia spilanthoides, Xerochrysum bracteatum*	

Bio-condition Site 10	
Non-native Species	*Praxelis clematidea*
Threatened Flora	*Eleutheroglossum fellowsii*

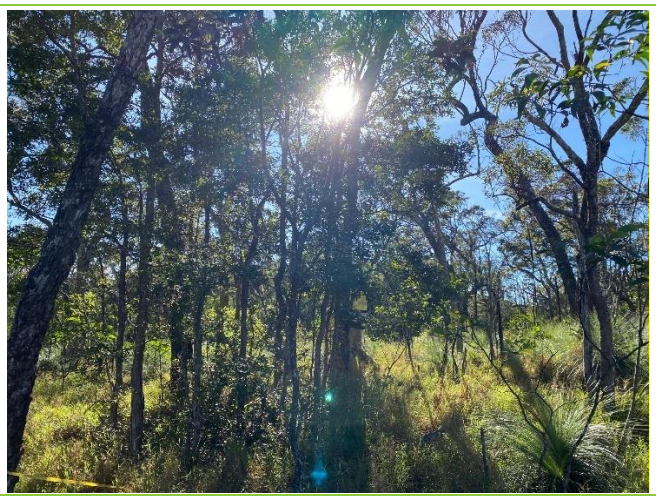
Table 11 Bio-condition Site 11

Bio-condition Site 11				
Date:	**03-02-2022**			
Plot Origin:	Zone: 55K	Lat: 17.19979	Long: 145.40494	Elevation: 1008m
Plot Centre:	Zone: 55K	Lat: 17.19971	Long: 145.40448	Elevation: 984m
Plot Bearing:	NW	**Plot Alignment:**	Running NW downslope across the contour line within a steep rocky gully	
				
North			East	
				
South			West	
Habitat Description:	Open forest with a canopy (18m) dominated by *Olea paniculata, Mallotus philippensis, Pleiogynium timorense, Pittosporum venulosum, Euroschinus falcata and Cupaniopsis anacardioides*. Emergent (25m) *Agathis robusta*.			
Regional Ecosystem (Mapped):	**7.12.7c** Simple to complex microphyll to notophyll vine forest, often with *Agathis robusta or A. microstachya,* on granites and rhyolites of moist foothills and uplands.			

Bio-condition Site 11			
Vegetation Attributes:	Recruitment of Dominant Canopy Species (%):		100%
	Native plant species richness:	Trees:	10
		Shrubs:	19
		Grasses:	1
		Forbs/Other:	20
	Tree Canopy	Median Height (m)	18
		Tree Canopy Cover (%)	77.7
	Tree Sub-canopy	Tree sub-canopy median Height (m)	8
		Tree Sub-canopy Cover	41.8
	Large Trees	Large Eucalypt tree DBH threshold (cm)	30
		Large Eucalypt trees per hectare	1
		Large non-eucalypt trees threshold (cm)	25
		Large non-eucalypt trees per hectare	24
	Shrubs	Native Shrub Cover (%)	9.8
	Ground Cover	Native Perennial Grass Cover (%)	0
		Forbs and Non-grass (%)	14
		Shrubs (%)	3
		Organic litter cover (%)	44
		Rock (%)	36
		Bare Ground (%)	3
		Cryptograms (%)	0
		Non-native plant cover (%)	<1
		Total Non-native species richness	1
	Coarse Woody Debris (CWD)	Total length >10cm width and >1m length (m)	36
Native Species Richness:	Trees	*Agathis robusta, Brachychiton alceifolius, Chionanthus ramiflorus, Corymbia intermedia, Elaeodendron melanocarpum, Pitaviaster haplophyllus, Polyscias elegans, Schefflera actinophylla, Syncarpia glomulifera, Syzygium johnsonii*	
	Shrubs	*Acronychia laevis, Alchornea ilicifolia, Alyxia ruscifolia, Alectryon tomentosus, Atractocarpus Fitzalania, Breynia stipitata, Clerodendrum longiflorum, Callicarpa pedunculata, Denhamia bilocularis, Drypetes deplanchei, Guioa acutifolia, Ligustrum australianum, Mallotus philippensis, Myrsine variable, Pittosporum venulosum, Polyalthia nitidissima, Psychotria loniceroides, Psychotria dallachiana, Wikstroemia indica*	

Bio-condition Site 11		
	Grasses	*Ottochloa gracillima*
	Forbs and Others	*Adiantum aethiopicum, Asplenium nidus, Alpinia caerulea, Boea hygroscopica, Calochlaena dubia, Clematis pickeringii, Commelina ensifolia, Dioscorea transversa, Gahnia aspera, Geitonoplesium cymosum, Microsorum punctatum, Parsonsia velutina, Plectranthus mirus, Plectranthus mirus, Pseuderanthemum variable, Pyrrosia rupestris, Smilax blumei, Smilax australis, Tetrastigma nitens, Trophis scandens*
Non-native Species		*Lantana camara*
Threatened Flora		Nil

Table 12 Bio-condition Site 12

<table>
<tr><th colspan="5">Bio-condition Site 12</th></tr>
<tr><td>Date:</td><td colspan="4">16-03-2022</td></tr>
<tr><td>Plot Origin:</td><td>Zone: 55K</td><td>Lat: 17.20494</td><td>Long: 145.40387</td><td>Elevation: 1075m</td></tr>
<tr><td>Plot Centre:</td><td>Zone: 55K</td><td>Lat: 17.20531</td><td>Long: 145.40411</td><td>Elevation: 1071m</td></tr>
<tr><td>Plot Bearing:</td><td>W</td><td>Plot Alignment:</td><td colspan="2">Near to ridge top following the contour</td></tr>
<tr><td colspan="3">  </td><td colspan="2">  </td></tr>
<tr><td colspan="3">North</td><td colspan="2">East</td></tr>
<tr><td colspan="3">  </td><td colspan="2">  </td></tr>
<tr><td colspan="3">South</td><td colspan="2">West</td></tr>
<tr><td>Habitat Description:</td><td colspan="4">Open forest with a canopy (12m) dominated by Eucalyptus drepanophylla, Corymbia intermedia and Syncarpia glomulifera. Sparse shrub layer (3m) contains Acrothamnus spathaceus, Allocasuarina torulosa, Acacia aulacocarpa and Lophostemon grandiflorus. Grassy understorey (0.5m) of Themeda triandra and Mnesithea rottboellioides</td></tr>
<tr><td>Regional Ecosystem (Mapped):</td><td colspan="4">7.12.34 Eucalyptus portuensis and/or E. drepanophylla, +/- C. intermedia +/- C. citriodora, +/- E. granitica open woodland to open forest on uplands on granite</td></tr>
<tr><td rowspan="3">Vegetation Attributes:</td><td colspan="3">Recruitment of Dominant Canopy Species (%):</td><td>100%</td></tr>
<tr><td rowspan="2">Native plant species richness:</td><td>Trees:</td><td>4</td></tr>
<tr><td>Shrubs:</td><td>8</td></tr>
</table>

Bio-condition Site 12			
		Grasses:	3
		Forbs/Other:	15
	Tree Canopy	Median Height (m)	12
		Tree Canopy Cover (%)	50.8
	Tree Sub-canopy	Tree sub-canopy median Height (m)	7
		Tree Sub-canopy Cover	9.5
	Large Trees	Large Eucalypt tree DBH threshold (cm)	30
		Large Eucalypt trees per hectare	24
		Large non-eucalypt trees threshold (cm)	30
		Large non-eucalypt trees per hectare	2
	Shrubs	Native Shrub Cover (%)	11.7
	Ground Cover	Native Perennial Grass Cover (%)	70
		Forbs and Non-grass (%)	5.2
		Shrubs (%)	11
		Organic litter cover (%)	7
		Rock (%)	6.8
		Bare Ground (%)	0
		Cryptograms (%)	0
		Non-native plant cover (%)	<1
		Total Non-native species richness	1
	Coarse Woody Debris (CWD)	Total length >10cm width and >1m length (m)	0
Native Species Richness:	Trees	*Allocasuarina torulosa, Corymbia intermedia, Eucalyptus drepanophylla, Syncarpia glomulifera*	
	Shrubs	*Acacia aulacocarpa, Acacia flavescens, Acrothamnus spathaceus, Astrotricha pterocarpa, Bursaria spinosa, Platysace valida, Polyscias elegans, Xanthorrhoea johnsonii*	
	Grasses	*Mnesithea rottboellioides, Ottochloa gracillima, Themeda triandra*	
	Forbs and Others	*Ajuga australis, Coronidium newcastlianum, Dianella nervosa, Eleutheroglossum fellowsii, Gahnia aspera, Geitonoplesium cymosum, Glycine sp., Hibbertia longifolia, Lepidosperma laterale, Lomandra multiflora, Panicum simile, Forb 1, Rostellularia adscendens, Widelia spilanthoides, Xerochrysum bracteatum,*	
Non-native species		*Praxelis clematidea*	
Threatened Flora		*Eleutheroglossum fellowsii*	

Table 13 Bio-condition Site 13

<table>
<tr><th colspan="5">Bio-condition Site 13</th></tr>
<tr><td>Date:</td><td colspan="4">16-03-2022</td></tr>
<tr><td>Plot Origin:</td><td>Zone: 55K</td><td>Lat: 17.20323</td><td>Long: 145.40465</td><td>Elevation: 1083m</td></tr>
<tr><td>Plot Centre:</td><td>Zone: 55K</td><td>Lat: 17.20279</td><td>Long: 145.40471</td><td>Elevation: 1087m</td></tr>
<tr><td>Plot Bearing:</td><td>W</td><td>Plot Alignment:</td><td colspan="2">Steep mid-slope, following contour</td></tr>
<tr><td colspan="3">  </td><td colspan="2">  </td></tr>
<tr><td colspan="3">North</td><td colspan="2">East</td></tr>
<tr><td colspan="3">  </td><td colspan="2">  </td></tr>
<tr><td colspan="3">South</td><td colspan="2">West</td></tr>
<tr><td>Habitat Description:</td><td colspan="4">Open woodland with a canopy (12m) dominated by Eucalyptus drepanophylla, Corymbia intermedia and Lophostemon grandiflorus. Understorey of Allocasuarina torulosa and canopy associates (5-8). Sparse shrub layer (3m) contains Acacia aulacocarpa. Grassy understorey (<1.0m) of Themeda triandra and Mnesithea rottboellioides and Capillipedium spicigerum.</td></tr>
<tr><td>Regional Ecosystem (Mapped):</td><td colspan="4">7.12.34 Eucalyptus portuensis and/or E. drepanophylla, +/- C. intermedia +/- C. citriodora, +/- E. granitica open woodland to open forest on uplands on granite.</td></tr>
<tr><td rowspan="3">Vegetation Attributes:</td><td colspan="3">Recruitment of Dominant Canopy Species (%):</td><td>100%</td></tr>
<tr><td rowspan="2">Native plant species richness:</td><td>Trees:</td><td>4</td></tr>
<tr><td>Shrubs:</td><td>6</td></tr>
</table>

Bio-condition Site 13			
		Grasses:	8
		Forbs/Other:	16
	Tree Canopy	Median Height (m)	12
		Tree Canopy Cover (%)	72.4
	Tree Sub-canopy	Tree sub-canopy median Height (m)	6.5
		Tree Sub-canopy Cover	15.9
	Large Trees	Large Eucalypt tree DBH threshold (cm)	30
		Large Eucalypt trees per hectare	20
		Large non-eucalypt trees threshold (cm)	30
		Large non-eucalypt trees per hectare	2
	Shrubs	Native Shrub Cover (%)	0.6
	Ground Cover	Native Perennial Grass Cover (%)	80
		Forbs and Non-grass (%)	3
		Shrubs (%)	0
		Organic litter cover (%)	10
		Rock (%)	2
		Bare Ground (%)	0
		Cryptograms (%)	0
		Non-native plant cover (%)	5
		Total Non-native species richness	2
	Coarse Woody Debris (CWD)	Total length >10cm width and >1m length (m)	0
Native Species Richness:	Trees	*Allocasuarina torulosa, eucalyptus drepanophylla, Corymbia intermedia, Lophostemon grandiflorus*	
	Shrubs	*Acacia aulacocarpa, Dodonaea lanceolata, Hibiscus merylkempsis, Platysace valida, Trema tomentosa, Xanthorrhoea johnsonii*	
	Grasses	*Capillipedium spicigerum, Digitaria sp., Gahnia aspera, Melenes repens, Mnesithea rottboellioides, Molasses grass, Panicum effusum, Themeda triandra*	
	Forbs and Others	*Adiantum aethiopicum, Chamaecrista nomame, Crotalaria brevis, Cheilanthes sieberi, Cyanthillium cinereum, Drynaria redijula, Forb 1, Forb 2, Geitonoplesium, Hibbertia longifolia, Lomandra multiflora, Phyllanthus simplex, Plectranthus amoenus, Pterocaulon redolens, Rostellularia adscendens, Scleria brownii*	
Non-native Species		*Stylo sp., Praxelis sp.*	
Threatened Flora		*Plectranthus amoenus*	

Table 14 Bio-condition Site 14

<table>
<tr><th colspan="6">Bio-condition Site 14</th></tr>
<tr><td>Date:</td><td colspan="5">23-03-2022</td></tr>
<tr><td>Plot Origin:</td><td>Zone: 55K</td><td>Lat: 17.20341</td><td colspan="2">Long: 145.40645</td><td>Elevation: 1114m</td></tr>
<tr><td>Plot Centre:</td><td>Zone: 55K</td><td>Lat: 17.20336</td><td colspan="2">Long: 145.40688</td><td>Elevation: 1120m</td></tr>
<tr><td>Plot Bearing:</td><td>E</td><td>Plot Alignment:</td><td colspan="3">Near to top of ridgeline, following contour</td></tr>
<tr><td colspan="3">  </td><td colspan="3">  </td></tr>
<tr><td colspan="3">North</td><td colspan="3">East</td></tr>
<tr><td colspan="3">  </td><td colspan="3">  </td></tr>
<tr><td colspan="3">South</td><td colspan="3">West</td></tr>
<tr><td>Habitat Description:</td><td colspan="5">Open woodland with a canopy (10m) dominated by Corymbia intermedia and/or Eucalyptus drepanophylla and Syncarpia glomulifera. Understorey of Allocasuarina torulosa and canopy associates (5-8). Sparse shrub layer (3m) contains Acacia aulacocarpa. Grassy understorey (<1.0m) of Themeda triandra and Mnesithea rottboellioides and Capillipedium spicigerum</td></tr>
<tr><td>Regional Ecosystem (Mapped):</td><td colspan="5">7.12.29a Corymbia intermedia, Eucalyptus tereticornis, E. drepanophylla open forest to low open forest and woodland with Allocasuarina torulosa, A. littoralis, Lophostemon suaveolens, Acacia cincinnata, A. flavescens, Banksia aquilonia and Xanthorrhoea johnsonii. Uplands, on granite and rhyolite.</td></tr>
<tr><td rowspan="2">Vegetation Attributes:</td><td colspan="4">Recruitment of Dominant Canopy Species (%):</td><td>100%</td></tr>
<tr><td colspan="2">Native plant species richness:</td><td colspan="2">Trees:</td><td>3</td></tr>
</table>

Bio-condition Site 14			
		Shrubs:	19
		Grasses:	8
		Forbs/Other:	22
	Tree Canopy	Median Height (m)	11
		Tree Canopy Cover (%)	27
	Tree Sub-canopy	Tree sub-canopy median Height (m)	4
		Tree Sub-canopy Cover	0
	Large Trees	Large Eucalypt tree DBH threshold (cm)	20
		Large Eucalypt trees per hectare	20
		Large non-eucalypt trees threshold (cm)	20
		Large non-eucalypt trees per hectare	2
	Shrubs	Native Shrub Cover (%)	35.9
	Ground Cover	Native Perennial Grass Cover (%)	33
		Forbs and Non-grass (%)	8
		Shrubs (%)	27
		Organic litter cover (%)	38
		Rock (%)	0
		Bare Ground (%)	0
		Cryptograms (%)	0
		Non-native plant cover (%)	<1
		Total Non-native species richness	1
	Coarse Woody Debris (CWD)	Total length >10cm width and >1m length (m)	0
Native Species Richness:	Trees	*Eucalyptus drepanophylla, Corymbia intermedia, Syncarpia glomulifera*	
	Shrubs	*Acacia aulacocarpa, Acacia implexa, Acrothamnus spathacea, Acrotriche aggregata, Allocasuarina littoralis, Allocasuarina torulosa, Alphitonia excelsa, Banksia aquilonia, Bursaria spinosa, Glochidion sumatranum, Hakea plurinervia, Hibiscus meraukensis, Hovea densivellosa, Lophostemon suaveolens, Notelaea venosa, Pittosporum venulosum, Pomaderris argyrophylla, Trema aspera, Xanthorrhoea johnsonii.*	
	Grasses	*Arundinella setosa, Capillipedium spicigerum, Cleistochloa subjuncea, Entolasia stricta, Mnesithea rottboellioides, Melinis minutiflora, Panicum effusum, Themeda triandra*	
	Forbs and Others	*Breynia stipitata, Calochlaena dubia, Coleus australis, Commelina ensifolia, Crassocephalum sp., Cyanthillium*	

Bio-condition Site 14		
		cinereum, Dendrobium jonesii, Dendrobium fellowsii, Desmodium rhytidophyllum, Dianella caerulea, Drynaria rigidula, Eustrephus latifolius Fabaceae vine, Flemingia parviflora, Glycine clandestina, Lepidosperma laterale, Lomandra multiflora, Pseuderanthemum variable, Rostellularia adscendens, Schelhammera multiflora, Tricoryne anceps, Widelia spilanthoides
Non-native Species		*Praxelis clematidea*
Threatened Flora		Nil

Table 15 Bio-condition Site 15

<table>
<tr><th colspan="6">Bio-condition Site 15</th></tr>
<tr><td>Date:</td><td colspan="5">23-03-2022</td></tr>
<tr><td>Plot Origin:</td><td>Zone: 55K</td><td>Lat: 17.19982</td><td colspan="2">Long: 145.40669</td><td>Elevation: 1056m</td></tr>
<tr><td>Plot Centre:</td><td>Zone: 55K</td><td>Lat: 17.19999</td><td colspan="2">Long: 145.40713</td><td>Elevation: 1055m</td></tr>
<tr><td>Plot Bearing:</td><td>NE</td><td>Plot Alignment:</td><td colspan="3">Mid-slope very steep slope following contour</td></tr>
<tr><td colspan="3">  </td><td colspan="3">  </td></tr>
<tr><td colspan="3">North</td><td colspan="3">East</td></tr>
<tr><td colspan="3">  </td><td colspan="3">  </td></tr>
<tr><td colspan="3">South</td><td colspan="3">West</td></tr>
<tr><td>Habitat Description:</td><td colspan="5">Open shrubland (<3m) dominated by Corymbia abergiana, Eucalyptus lockyeri and Syncarpia glomulifera. Grassy understorey (<1.0m) of Themeda triandra and Mnesithea rottboellioides and Capillipedium spicigerum</td></tr>
<tr><td>Regional Ecosystem (Mapped):</td><td colspan="5">7.12.57a Shrubland and low woodland mosaic with Syncarpia glomulifera, Corymbia abergiana, Eucalyptus portuensis, Allocasuarina littoralis and Xanthorrhoea johnsonii. Uplands and highlands on granite and rhyolite, of the moist and dry rainfall zones.</td></tr>
<tr><td rowspan="3">Vegetation Attributes:</td><td colspan="4">Recruitment of Dominant Canopy Species (%):</td><td>N/A</td></tr>
<tr><td rowspan="2">Native plant species richness:</td><td colspan="3">Trees:</td><td>0</td></tr>
<tr><td colspan="3">Shrubs:</td><td>12</td></tr>
</table>

Bio-condition Site 15			
		Grasses:	9
		Forbs/Other:	24
	Tree Canopy	Median Height (m)	N/A
		Tree Canopy Cover (%)	0
	Tree Sub-canopy	Tree sub-canopy median Height (m)	N/A
		Tree Sub-canopy Cover	0
	Large Trees	Large Eucalypt tree DBH threshold (cm)	N/A
		Large Eucalypt trees per hectare	0
		Large non-eucalypt trees threshold (cm)	N/A
		Large non-eucalypt trees per hectare	0
	Shrubs	Native Shrub Cover (%)	50.1
	Ground Cover	Native Perennial Grass Cover (%)	39
		Forbs and Non-grass (%)	7
		Shrubs (%)	35
		Organic litter cover (%)	0
		Rock (%)	12
		Bare Ground (%)	7
		Cryptograms (%)	0
		Non-native plant cover (%)	<1
		Total Non-native species richness	1
	Coarse Woody Debris (CWD)	Total length >10cm width and >1m length (m)	Nil
Native Species Richness:	Trees	Nil (shrubland)	
	Shrubs	*Acacia calyculata, Acacia flavescens, Allocasuarina littoralis, Eucalyptus crebra, Hakea benthamii, Lophostemon suaveolens, Melichrus adpressus, Persoonia falcata, Platysace valida, Sannantha angusta, Syncarpia glomulifera, Xanthorrhoea johnsonii*	
	Grasses	*Alphitonia excelsa, Aristida utilis, Arundinella setosa, Capillipedium spicigerum, Cymbopogon bombycinus, Mnesithea rottboellioides, Panicum simile, Themeda triandra, Tripogon loliiformis*	
	Forbs and Others	*Brunoniella australis, Clematicissus opaca, Cyanthillium cinereum, Cheilanthes brownii, Coronidium newcastlianum, Crotalaria brevis, Desmodium rhytidophyllum, Dianella nervosa, Glycine clandestina, Glycine tabacina, Hypericum gramineum, Lomandra filiformis, Acianthus borealis, Mitrasacme sp., Oxalis radicans, Xerochrysum*	

Bio-condition Site 15		
		newcastlianum, Poranthera microphylla, Rostellularia adscendens, Scleria brownii, Thysanotus tuberosa, Tricoryne anceps, Wahlenbergia sp., Widelia spilanthoides, Zornia sp.
Non-native Plant Species		*Praxelis clematidea*
Threatened Flora		Nil

Table 16 Bio-condition Site 16

Bio-condition Site 16				
Date:	**26-05-2020**			
Plot Origin:	Zone: 55K	Lat: 17.19669	Long: 145.39780	Elevation: 1036m
Plot Centre:	Zone: 55K	Lat: 17.19627	Long: 145.39784	Elevation: 1036m
Plot Bearing:	SE	**Plot Alignment:**	Top of ridge following contour	
				
North			East	
				
South			West	
Habitat Description:	Open shrubland to heathland (<2m) with occasional rock pavement outcrops			
Regional Ecosystem (Mapped):	**7.12.57c** Shrubland/low woodland (1.5-9m tall) mosaic with variable dominance, often including *Eucalyptus cloeziana, Corymbia abergiana, E. portuensis, E. reducta, E. lockyeri, C. leichhardtii, Callitris intratropica, E. atrata, E. pachycalyx, E. shirleyi, E. drepanophylla and*			

Bio-condition Site 16			
	Homoranthus porteri, on rhyolite and granite. There is occasionally a very sparse to sparse secondary tree layer of *Corymbia abergiana and/or C. stockeri*. A very sparse to sparse tall shrub layer may be present and can include *Persoonia falcata, Exocarpos cupressiformis and Melaleuca viridiflora var. viridiflora*. A sparse to dense lower shrub layer may include *Jacksonia thesioides, Acacia calyculata, Coelospermum reticulatum, Xanthorrhoea johnsonii, Acacia humifusa, Dodonaea lanceolata var. subsessilifolia, Grevillea dryandri subsp. dryandri, Grevillea glossadenia, Acacia umbellata and Ericaceae spp*. The ground layer may be dominated by species such as *Themeda triandra, Xanthorrhoea johnsonii, Eriachne pallescens var. pallescens, Cleistochloa subjuncea, Borya septentrionalis, and Eriachne spp*. Includes open rocky dominated by herbs and grasses. This RE includes areas of 7.12.65k (rocky areas with shrubby/herbaceous cover) which are too small to map. Rocky slopes on granite and rhyolite.		
Vegetation Attributes:	Recruitment of Dominant Canopy Species (%):		N/A
	Native plant species richness:	Trees:	2
		Shrubs:	16
		Grasses:	8
		Forbs/Other:	17
	Tree Canopy	Median Height (m)	N/A
		Tree Canopy Cover (%)	0
	Tree Sub-canopy	Tree sub-canopy median Height (m)	1.3
		Tree Sub-canopy Cover	0
	Large Trees	Large Eucalypt tree DBH threshold (cm)	20
		Large Eucalypt trees per hectare	8
		Large non-eucalypt trees threshold (cm)	N/A
		Large non-eucalypt trees per hectare	0
	Shrubs	Native Shrub Cover (%)	19.2
	Ground Cover	Native Perennial Grass Cover (%)	28
		Forbs and Non-grass (%)	0
		Shrubs (%)	54
		Organic litter cover (%)	5
		Rock (%)	5
		Bare Ground (%)	4
		Cryptograms (%)	2
		Non-native plant cover (%)	2
		Total Non-native species richness	1
	Coarse Woody Debris (CWD)	Total length >10cm width and >1m length (m)	Nil
	Trees	*Eucalyptus reducta, Eucalyptus crebra,*	

Bio-condition Site 16		
Native Species Richness:	Shrubs	*Acacia aulacocarpa, Acacia calyculata, Acrothamnus spathaceus, Allocasuarina inophloia, Aristida sp., Eucalyptus lockyeri, Eriachne sp., Hakea benthamii, Leptospermum amboinensis, Melaleuca uxorum, Melichrus adpressus, Persoonia falcata, Platysace valida, Pseudanthus ligulatus, Sannantha augusta, Xanthorrhoea johnsonii*
	Grasses	*Cleistochloa subjuncea, Cymbopogon bombycinus, Digitaria sp., Dimeria ornithopoda, Eragrostis schultzii, Eriachne mucronata, Schizachyrium fragile, Tripogon loliiformis*
	Forbs and Others	*Boronia occidentalis, Borya septemtrionalis, Cheilanthes distans, Cheilanthes nitida, Coronidium newcastlianum, Cymbopogon bombycinus, Drosera lunata, Gonocarpus acanthocarpus, Hibbertia longifolia, Hovea nana, Hypericum gramineum, Lepidosperma laterale, Mitrasacme sp., Pimelea linariifolia, Pterocaulon redolens, Sedopsis sp., Tricoryne anceps*
Non-native Plant Species		Nil
Threatened Flora		*Melaleuca uxorum*

Table 17 Bio-condition Site 17

Bio-condition Site 17				
Date:	**18-02-2022**			
Plot Origin:	Zone: 55K	Lat: 17.19696	Long: 145.39706	Elevation: 1045m
Plot Centre:	Zone: 55K	Lat: 17.19702	Long: 145.39746	Elevation: 1045m
Plot Bearing:	SE	**Plot Alignment:**	Top of ridge following the contour	
				
North			East	

<table>
<tr><th colspan="4">Bio-condition Site 17</th></tr>
<tr><td colspan="2">  </td><td colspan="2">  </td></tr>
<tr><td colspan="2">South</td><td colspan="2">West</td></tr>
<tr><td>Habitat Description:</td><td colspan="3">Rhyolite rock pavement outcrops sloping on a SW aspect. Mosaic of rock pavement and heathland vegetation.</td></tr>
<tr><td>Regional Ecosystem (Mapped):</td><td colspan="3">7.12.65k Granite and rhyolite rock outcrop, of dry western areas, associated with shrublands to closed forests of Acacia spp. and/or Lophostemon spp. and/or Allocasuarina spp. In the Mount Emerald area, shrubs may include Acacia umbellata, Melaleuca borealis, Homoranthus porteri, Leptospermum neglectum, Melaleuca recurva, Melaleuca uxorum, Grevillea glossadenia, Corymbia abergiana, Eucalyptus lockyeri, Sannantha angusta, Pseudanthus ligulatus subsp. ligulatus, Acacia aulacocarpa, Leptospermum amboinense, Xanthorrhoea johnsonii and Jacksonia thesioides. Ground-cover species may include Borya septentrionalis, Lepidosperma laterale, Eriachne spp., Cleistochloa subjuncea, Boronia occidentalis, Cheilanthes spp., Coronidium newcastlianum, Schizachyrium spp., Tripogon loliiformis, Gonocarpus acanthocarpus and Eragrostis spp. Dry western areas. Granite and rhyolite.</td></tr>
<tr><td rowspan="11">Vegetation Attributes:</td><td colspan="2">Recruitment of Dominant Canopy Species (%):</td><td>N/A</td></tr>
<tr><td rowspan="4">Native plant species richness:</td><td>Trees:</td><td>0</td></tr>
<tr><td>Shrubs:</td><td>12</td></tr>
<tr><td>Grasses:</td><td>10</td></tr>
<tr><td>Forbs/Other:</td><td>16</td></tr>
<tr><td rowspan="2">Tree Canopy</td><td>Median Height (m)</td><td>N/A</td></tr>
<tr><td>Tree Canopy Cover (%)</td><td>0</td></tr>
<tr><td rowspan="2">Tree Sub-canopy</td><td>Tree sub-canopy median Height (m)</td><td>N/A</td></tr>
<tr><td>Tree Sub-canopy Cover</td><td>0</td></tr>
<tr><td rowspan="4">Large Trees</td><td>Large Eucalypt tree DBH threshold (cm)</td><td>N/A</td></tr>
<tr><td>Large Eucalypt trees per hectare</td><td>0</td></tr>
<tr><td>Large non-eucalypt trees threshold (cm)</td><td>N/A</td></tr>
<tr><td>Large non-eucalypt trees per hectare</td><td>0</td></tr>
<tr><td>Shrubs</td><td>Native Shrub Cover (%)</td><td>11.3</td></tr>
</table>

Bio-condition Site 17			
	Ground Cover	Native Perennial Grass Cover (%)	16
		Forbs and Non-grass (%)	0
		Shrubs (%)	18
		Organic litter cover (%)	0
		Rock (%)	56
		Bare Ground (%)	3
		Cryptograms (%)	1
		Non-native plant cover (%)	6
		Total Non-native species richness	1
	Coarse Woody Debris (CWD)	Total length >10cm width and >1m length (m)	Nil
Native Species Richness:	Trees	N/A	
	Shrubs	*Acacia aulacocarpa, Acrothamnus spathaceus, Eucalyptus lockyeri, Hibbertia stirlingii, Leptospermum amboinensis, Melaleuca uxorum, Melichrus adpressus, Platysace valida, Pseudanthus ligulatus, Sannantha angusta, Seringia lanceolata, Xanthorrhoea johnsonii,*	
	Grasses	*Aristida sp., Cleistochloa subjuncea, Cymbopogon bombycinus, Digitaria sp., Eragrostis schultzii, Eriachne mucronate, Panicum simile, Schizachyrium fragile, Themeda triandra, Tripogon loliiformis*	
	Forbs and Others	*Boronia occidentalis, Borya septentrionalis, Caladenia sp., Cheilanthes distans, Coronidium newcastlianum, Cyanthillium cinereum, Drosera lunata, Fimbristylis dichotoma, Gonocarpus acanthocarpus, Hypericum gramineum, Lepidosperma laterale, Mitrasacme sp., Pimelea linariifolia, Phyllanthus dallachyanus, Plectranthus amoenus, Tricoryne anceps*	
Non-native Plant Species		*Praxelis clematidea*	
Threatened Flora		*Melaleuca uxorum, Plectranthus amoenus*	

Table 18 Bio-condition Site 18

Bio-condition Site 18				
Date:	**18-02-2022**			
Plot Origin:	Zone: 55K	Lat: 17.19645	Long: 145.39725	Elevation: 1064m
Plot Centre:	Zone: 55K	Lat: 17.19612	Long: 145.39754	Elevation: 1058m
Plot Bearing:	SE	**Plot Alignment:**	Mid-slope running parallel to the hill contour	
				
North			East	
				
South			West	

Habitat Description:	Open forest (14m) dominated by *Eucalyptus reducta.* Grassy understorey (<1.0m) of *Themeda triandra* and *Mnesithea rottboellioides* combined with a low heathy shrub layer		
Regional Ecosystem (Mapped):	**7.12.58** *Eucalyptus reducta* +/- *E. granitica* +/- *Corymbia dimorpha* +/- *C. citriodora* woodland to open forest on granite and rhyolite		
Vegetation Attributes:	Recruitment of Dominant Canopy Species (%):		100%
	Native plant species richness:	Trees:	2
		Shrubs:	10
		Grasses:	4
		Forbs/Other:	11

Bio-condition Site 18			
	Tree Canopy	Median Height (m)	14
		Tree Canopy Cover (%)	23.5
	Tree Sub-canopy	Tree sub-canopy median Height (m)	5
		Tree Sub-canopy Cover	0
	Large Trees	Large Eucalypt tree DBH threshold (cm)	30
		Large Eucalypt trees per hectare	32
		Large non-eucalypt trees threshold (cm)	0
		Large non-eucalypt trees per hectare	0
	Shrubs	Native Shrub Cover (%)	30.2
	Ground Cover	Native Perennial Grass Cover (%)	34
		Forbs and Non-grass (%)	0
		Shrubs (%)	24
		Organic litter cover (%)	12
		Rock (%)	9
		Bare Ground (%)	8
		Cryptograms (%)	0
		Non-native plant cover (%)	13
		Total Non-native species richness	1
	Coarse Woody Debris (CWD)	Total length >10cm width and >1m length (m)	32.5
Native Species Richness:	Trees	*Eucalyptus crebra, Eucalyptus reducta*	
	Shrubs	*Acacia calyculata, Acrothamnus spathaceus, Astrotricha pterocarpan, Hakea benthamii, Hibiscus normanii, Melichrus urceolatus, Notelaea venosa, Platysace valida, Pultenaea millarii, Xanthorrhoea johnsonii,*	
	Grasses	*Cleistochloa subjuncea, Eriachne mucronata, Panicum simile, Themeda triandra.*	
	Forbs and Others	*Cheilanthes brownii, Coronidium newcastlianum, Dianella nervosa, Dipodium sp., Hibbertia longifolia, Lepidosperma laterale, Lomandra filiformis, Phyllanthus dallachyanus, Pimelea linariifolia, Plectranthus parviflora, Tricoryne anceps.*	
Non-native Flora	Praxelis clematidea		
Threatened Flora	Nil		

DATE	PERSON	EDIT
31/03/2022	Ryan	Added this document to 2022 job folder
31/03/2022	Susie	Updated tables for Biocondition site 1, 2, and 3
01/04/2022	Susie	Updated tables for Biocondition site 4, 5, 6, and 8.
20/04/2022	Patricia	Updated tables for Biocondition site 11, 12, 13, 14, 15, 16, 17 and 18.